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NATIONAL DAM SAFETY PROGRAM. BOTTOM DIGGINS DAM (MO 30750), MIS--ETC(U)
SEP 79 K B KING, J H GRAY, D E WESTCOTT DACW53-79-C-0037

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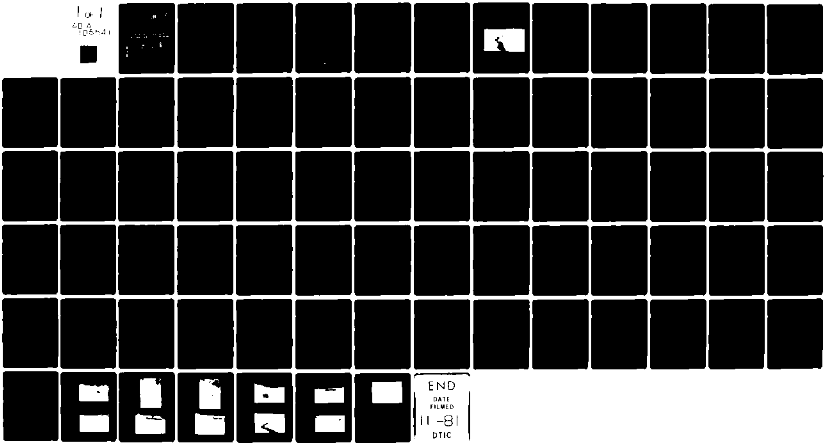

MISSISSIPPI-KASKASKIA-ST. LOUIS BASIN

AD A105541

LEVEL II

BOTTOM DIGGINS DAM
WASHINGTON COUNTY, MISSOURI
MO 30750

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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SUBJECT: Bottom Diggins Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Bottom Diggins Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1) Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam and significant erosion to the left abutment spillway.

2) Overtopping of the dam and/or significant erosion of the spillway could result in failure of the dam.

3) Dam failure significantly increases the hazard to loss of life downstream.

For Phase I reports, the extent of the downstream damage zone has been determined assuming that all materials contained by the tailings dam are in a liquid state.

SIGNED

6 MAY 1980

SUBMITTED BY: ______________________________ Chief, Engineering Division ____________ Date

SIGNED

7 MAY 1980

APPROVED BY: ______________________________ Colonel, CE, District Engineer ____________ Date

BOTTOM DIGGINS DAM
WASHINGTON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30750

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM,

Bottom Diggins Dam (MO 30750),
Mississippi - Kaskaskia - St. Louis Basin,
Washington County, Missouri. Phase I
Inspection Report.

PREPARED BY

INTERNATIONAL ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
SAN FRANCISCO, CALIFORNIA

9 Final rept.,

15 DACW53-79-C-0037

10 Kenneth B. /King James H. /Gray
Donald E. /Westcott

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI 12

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PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Bottom Diggins Dam
State	Missouri
County	Washington
Stream	Unnamed Tributary to Mill Creek
Date of Inspection	11-12 April 1979

Bottom Diggins Dam, I.D. No. 30750, owned by Baroid Division of N. L. Industries, Potosi, Missouri, was inspected by a civil engineer and an engineering geologist from International Engineering Company, Inc. of San Francisco, California. The purpose of the inspection was to assess the general condition of the dam with respect to safety. The assessment is based upon an evaluation of the available data, a visual inspection, and an evaluation of the hydrology and hydraulics of the site in order to determine if the dam poses hazards to human life or property. The dam provides impoundment for barite ore tailings.

Bottom Diggins Dam was inspected using the "Recommended Guidelines for Safety Inspection of Dams" furnished by the Department of the Army, Office of the Chief of Engineers. Based on these Guidelines, this dam is classified as being of intermediate size. The St. Louis District Corps of Engineers has classified this dam to have a high downstream hazard potential. Failure of this dam could threaten life and property. The estimated damage zone provided by the St. Louis District Corps of Engineers extends approximately three and one-half miles downstream of the dam. There are 20 dwellings, a dam and a bridge within this damage zone.

The results of the inspection and evaluation indicate that the spillway does not meet the criteria given in the guidelines for a dam with the size and hazard potential of Bottom Diggins Dam. As an intermediate size dam with a high hazard potential, the Guidelines specify that the discharge capacity and/or storage capacity should be capable of safely handling the Probable Maximum Flood (PMF) without overtopping the crest. The PMF is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

It was calculated that the spillways can pass a 100-year flood (a flood having a 1 percent chance of being equalled or exceeded in any 1 year) without overtopping the dam. It was also estimated that the spillways could pass 3 percent of the PMF without overtopping the dam and without significant erosion of the left abutment spillway; however, the spillways cannot pass 50 percent of the PMF without overtopping and significant erosion.

Adequate overflow facilities should be provided so that the impoundment can safely handle the PMF without overtopping the crest and without significant erosion of the left abutment spillway or embankment.

Extensive seepage and conditions indicating poor drainage and soft, potentially unstable foundation conditions were observed along the dam toe. Corrective action should be initiated immediately to rectify this serious deficiency.

Also, excessive wave erosion on the upstream slope and animal burrows and dead trees were noted. No erosion protection is provided in the left abutment spillway. Access to the dam is difficult during periods of storm runoff. These deficiencies should be corrected in the near future.

Seepage and stability analyses of this dam are not available. These studies should be performed by a professional engineer experienced in the design and construction of tailings dams and should be made a matter of record. Based on the results of these analyses, remedial measures may become necessary. Remedial work should be performed under the direction of an engineer experienced in the design and construction of tailings dams.

An inspection and maintenance program should be initiated. Periodic inspections should be made and documented by qualified personnel to observe the performance of the dam and spillway.

It is recommended that the owner take action to correct the deficiencies described.

Kenneth B. King, P.E.

James H. Gray, P.E.

Donald E. Westcott

Overview of Bottom Diggins Dam (30750) from the Left Abutment

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BOTTOM DIGGINS DAM
ID. NO. 30750

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NATIONAL DAM SAFETY PROGRAM

BOTTOM DIGGINS DAM - ID NO. 30750

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Bottom Diggins Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to assess the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These Guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

(1) Type of dam - Bottom Diggins Dam is an earthfill dam that impounds barite tailings and water. The impoundment is formed by an cross-valley dam.

(2) Spillways - An uncontrolled open channel spillway is located at the left abutment. A breached area located in the reservoir rim approximately 430 feet southwest of the right abutment of the dam also acts as a spillway.

b. Location. The dam is located in Washington County, Missouri, as shown in Plate 1. The dam is shown in Plate 2 and is located in Section 21, Township 38 North, Range 3 East.

c. Size Classification. Bottom Diggins Dam is greater than 40 feet but less than 100 feet high and therefore is classified as an intermediate size dam in accordance with "Recommended Guidelines for the Safety Inspection of Dams".

d. Hazard Classification. This dam is classified as having a high hazard potential by the St. Louis District Corps of Engineers. The estimated damage zone, as provided by the St. Louis District Corps of Engineers, extends approximately three and one-half miles downstream. There are 20 dwellings, a bridge and a dam within this damage zone.

e. Ownership. This dam is owned by:

Baroid Division
N. L. Industries
P. O. Box 8
Potosi, Missouri 63664

f. Purpose of Dam. The dam impounds water and tailings resulting from a barite separation and benefication process. Tailings are no longer conveyed to the impoundment.

g. Design and Construction History. There is no written design or construction data available for this dam. Information obtained from Mr. Clarence Houk, General Superintendent for Baroid indicates that the starter dam was built in 1944 by National Lead Company. The impoundment was abandoned in 1957. Baroid constructed the toe berm at some unknown date.

h. Normal Operating Procedures. No operating records are known to exist. Runoff into the pond is removed by the spillways, seepage into the tailings, and evaporation. The facility is inactive in that tailings are no longer conveyed to the impoundment.

1.3 PERTINENT DATA

a. General. Field surveys were made by Booker Associates, Inc. of St. Louis, Missouri on 25 April 1979. Measurements are valid as of the dates of inspection and survey.

b. Drainage Area. 1110 acres (1.73 sq. miles) - (from USGS 7.5-minute Tiff quadrangle sheet).

c. Discharge at Damsite.

(1) Outlet Pipes - Not functional.

(2) Total spillway discharge -

(a) Maximum discharge experienced at site - No information available.

(b) Total computed discharge at maximum pool elevation -

(1) left abutment spillway - 460 cfs

(2) breach spillway - 2240 cfs

d. Elevation (Feet Above M.S.L.)[1/]

(1) Top of dam - El. 847.1 to 850.5 feet.

(2) Toe of dam - El. 809.2 feet.

(3) Maximum pool - El. 847.1 feet.

(4) Pool elevation on April 25, 1979 - 842.9 feet.
April 11, 1979 - 843.3 feet.

(5) Spillway crest -

(a) left abutment spillway - El. 842.3 feet.

(b) breach spillway - El. 842.3 feet

(6) Overflow pipes (invert) - Sta 5+12 - El. 846.8 feet.
Sta 5+21 - El. 845.7 feet.

(7) Intake structure - Not applicable.

d. Reservoir.

(1) Length of maximum pool - 2500 feet ±.

(2) Length of operating pool - 1800 feet ±.

e. Storage to Top of Dam - 280 acre-feet. (Both ponds combined)

f. Reservoir Surface Area.

(1) Top of dam - 85 acres at El. 847.1 feet. (Both ponds combined)

(2) Operating pool - 38 acres at El. 842.3 feet.

(3) Spillway crest - 38 acres at El. 842.3 feet.

g. Dam.

(1) Type - Earthfill.

(2) Length (crest) - 1300 feet.

(3) Height - 41.2 feet at Station 8+75.

[1/] Elevations are based on a reference elevation of 853.47 feet M.S.L. at the temporary bench mark. This datum was estimated from topographic date presented on the Tiff 7.5 minute Quadrangle Map.

(4) Crest width - Variable from 15 to 25 feet.

(5) Side Slopes -

(a) D/S - Approximately 1V on 1.5H

(b) U/S - Unknown

(6) Zoning - The dam appears to be constructed in a manner consistent with the prevailing barite dam construction practice. This method consists of a clay starter enlarged using minus 7/8-inch gravels.

(7) Cutoff - There is no written information available to indicate that a cutoff was designed or constructed.

h. Spillway.

(1) Type -

(a) Left abutment spillway - This spillway is an uncontrolled open channel spillway with a trapezoidal cross-section.

(b) Breach spillway - This spillway consists of a low area on the reservoir rim which passes outflow unchanneled into a strip mined area south of the dam.

(2) Control Section -

(a) Left abutment spillway - 12 foot bottom width, 1.5V on 1H side slopes.

(b) Breach spillway - Effective 42 foot bottom width opening in reservoir rim with 1V on 1H side slopes.

(3) Crest Elevation -

(a) Left abutment spillway - El. 842.3 feet.

(b) Breach spillway - El. 842.3 feet.

(4) Upstream Channel -

(a) Left abutment spillway - Not applicable.

(b) Breach spillway - Not applicable.

(5) Downstream Channels -

(a) Left abutment spillway - The channel is 800 feet long open cut; the flat channel slope changes to super-critical 250 feet downstream from the reservoir. This channel discharges into the original stream channel approximately 350 feet below the dam toe.

(b) Breach spillway - Flood flows have eroded a shallow channel draining easterly through a strip-mined area and into a ditch adjacent to Highway E.

j. Outlets. Note that these pipes are considered to be non-functional. They are probably abandoned decant lines.

(1) Length -

(a) Pipe #1 - 6 inch pipe - 80 feet ±.

(b) Pipe #2 - 6 inch pipe - 110 feet ±.

(2) Invert of Pipe at Upstream End -

(a) Pipe #1 - Sta 5+12 at El. 845.7 feet

(b) Pipe #2 - Sta 5+21 at El. 846.8 feet

(3) Invert of Pipe at Downstream End -

(a) Pipe #1 - Sta 5+62 at El. 826.9 feet

(b) Pipe #2 - Sta 6+24 at El. 829.4 feet

(4) Type - 6 inch diameter steel pipes.

(5) Shape of Entrance (both) - almost vertical riser pipes (square edge).

(6) Slope (both) - unknown.

(7) Flow at Time of Inspection -

(a) Pipe #1 was flowing at 1/4 gallon per minute.

(b) Pipe #2 was dry.

k. Diversion Ditches. - Not applicable.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design drawings or data are known to exist.

2.2 CONSTRUCTION

a. Information. The dam was built in 1944 by National Lead Company. There are no records concerning construction methods, materials, or procedures. Information provided verbally by Mr. Clarence Houk indicates that a berm was constructed of minus 7/8-inch gravel and rock on the dam toe to buttress the embankment and control extensive seepage at the dam toe. Some foundation preparation was accomplished with a dragline prior to placement of rock and gravel fill for the toe berm. Several pipes were installed for drainage. The date of this modification is not known.

b. Assessment of Construction Method and Materials. Procedures used to build this dam were developed using trial and error techniques over the last 60 years. After construction of the starter dam, sand and angular gravels (finer than 7/8-inch) were hauled to the crest of the dam, end-dumped, and spread; and excess material was pushed over the upstream and downstream faces of the dam. The sands and gravels placed in this manner are in a loose state and are at their natural angle of repose on the downstream face. The material pushed over the upstream side rests on the tailings. The centerline of the dam remains approximately at the same position as the embankment is raised. Compaction of the material on the crest was by construction equipment.

The minus 7/8-inch gravels were used to enlarge this tailings dam. They are free draining, angular, and relatively well-graded through the gravel and coarse sand range. The gravel appears to function well as a drain material, and it also functions fairly well as erosion protection from rainfall; however, it is inadequate to prevent erosion from channeled surface flow with a velocity greater than 4 to 6 feet per second.

2.3 OPERATION

The impoundment was operated by National Lead Company and Baroid Division of NL Industries until 1957. No records of operation are known to exist. A rock toe berm was installed by Baroid at an unknown date.

2.4 EVALUATION

a. Availability. No design or construction records were available. The only information made available to the inspection team was provided

during conversations with Mr. Clarence Houk, General Superintendent of Baroid Division of N. L. Industries, present owner of the facility.

b. Adequacy. The field surveys and visual inspections documented herein are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of "Recommended Guidelines for the Safety Inspection of Dams" are not available; the lack of these analyses is considered to be a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions, including earthquake loads, and should be made a matter of record.

c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. The inspection team consisted of a civil engineer and an engineering geologist from International Engineering Company, Inc. Clarence Houk, General Superintendent for Baroid Division of N. L. Industries, met with the inspection team on 10 April 1979. An employee escorted the team to the damsite. The facility is an abandoned tailings and water impoundment. Photographs taken during the inspection are included in this report; locations are shown on Plate 7.

b. Project Geology. Bedrock at the site is gray dolomite of the Cambrian age Potosi Formation. Isolated outcrops of bedrock were found in mined out areas adjacent the dam and in the spillway channel. Up to 15 feet of residual soil overlies bedrock. The residual overburden soil consists of dark red and brown barite rich clays derived from weathering of the dolomite. Intermixed with the clays are rock fragments consisting of barite, quartz, chert and dolomite which grade from sand to boulders.

c. Dam. The plan of the dam is shown on Plate 3. The profile and cross-sections are shown on Plates 4 and 5.

The slopes of the dam were densely covered with trees and brush. Some of the trees on the upstream slope have died.

No detrimental settlement, depressions, sinkholes, or evidence of past embankment overtopping was observed at the embankment.

The embankment gravels are standing near or at the angle of repose for the material.

A rock and gravel berm was observed at the dam toe approximately between Stations 11+00 and 6+00. The crest of this berm was approximately 10 feet wide and the slope is approximately 1V on 1.5H.

Extensive seepage and interrupted drainage was observed at the dam toe.

Station	Flow	Turbidity
3+00	3 gpm	clear
4+00	1 gpm	clear
4+76	5 gpm	clear
11+27	10 gpm	turbid

The Spring at station 11+27 showed some evidence of having piped embankment material in the past. Also, clear water was flowing from several drain pipes buried in the gravel and rock toe berm.

Station		
6+43	8 inch steel pipe	2 gpm
6+94	8 inch steel pipe	1 gpm
8+75	8 inch steel pipe	5 gpm
10+67	6 inch steel pipe	1/4 gpm

The ground conditions at the dam toe are extremely soft and marshy.

Erosion was observed on the upstream slope and on the crest of the dam near a dead tree. The crest erosion was repaired with coarse gravel (minus 4-inch to plus 7/8-inch) A beach has formed on the upstream face for the entire crest length and has eroded into the crest near Station 5+00. No slope protection material is present on the upstream slope of the dam.

Three animal burrows were observed in the upstream slope near Station 5+00.

Freeboard above the observed reservoir level at the dam varied from 4.6 to 7.6 feet. The low point on the dam crest was located by the right abutment at Station 14+03.

Both abutments consist of residual soil. The left abutment is relatively undisturbed. Extensive strip mining activity has occurred on the right abutment and along the reservoir rim south of the dam. The reservoir rim breached south of the right abutment and another spillway was formed.

d. Appurtenant Structures. The impoundment has two spillways. One spillway is located on the left abutment approximately 10 feet from the embankment at Sta. 1+75 and another at a breached area between Sta. 18+88 to Sta. 20+15 on the right abutment. On the date of inspection 11 April, 1979 both spillways were operating. Approximate depth of flow at the left abutment spillway was 1.0 feet and the approximate depth of flow at the breach spillway was 1.0 feet. The spillway at the left abutment is an open cut of trapezoidal cross-section with approximate side slopes of 1(H) to 1.5(V) and a bottom width varying from 12 to 20 feet. The channel bottom is armored with cobbles and bedrock is exposed in various areas. Erosion of the channel walls was observed during operation of this spillway.

A wide breach in the reservoir shore rim approximately 450 feet southwest of the right abutment (approximate from Sta. 18+88 to Sta. 20+15) is also functioning as a spillway. No channel downstream from this breach exists other than a shallow waterway which has been eroded in a strip mined area.

Two decant lines running through the dam were located. They are 6 inch steel pipes with vertical 6-inch riser inlets. No means of controlling these pipes was located. Limited discharge capacity is available through these pipes.

e. Reservoir Area. No landslide activity or excessive erosion was observed in the reservoir area. Erosion occurs in numerous strip mined areas in the drainage basin. There are no upstream structures that might be subject to backwater flooding.

The lower impoundment consists of water overlying red silty clays deposited by hydraulic methods during active mine operations. No deposition has occurred for approximately 22 years.

f. Downstream Channels. Overflow from the left abutment spillway would flow down the channel approximately 800 feet to a tributary of Mill Creek. The tributary channel is V-shaped, heavily overgrown and does not appear to be subject to flooding.

Overflow from the breached area on the reservoir rim south of the right abutment near Station 19+00 would flow east into a strip-mined area and eventually into the Mill Creek tributary of the bridge on Highway E.

3.2 EVALUATION

Seepage, pools of water, interrupted drainage, and soft, marshy ground was observed over much of the dam toe. No provision for draining this water away from the toe was evident. This situation could result in weakening of the foundation clay soil by saturation and adversely affect the stability of the dam.

Some evidence of past piping of embankment material was observed in a spring at Station 11+27. Since this situation could adversely affect the stability of the dam, this area requires close monitoring.

A wave cut beach was observed on the upstream slope. The upstream slope is being eroded and could eventually breach the crest. No slope protection is present other than that provided by some trees growing on the crest.

The left abutment spillway is located approximately 10 feet from the left abutment contact at Sta. 1+75. Continued erosion of the right bank of this spillway channel could eventually result in erosion of embankment materials.

The breached area causes no immediate stability problems for the dam. However, access to the dam is restricted during storm events due to outflow flowing across the access road to the right abutment.

Other deficiencies noted were animal burrows on the upstream slope and dead trees on the dam. These burrows and decayed root structures could provide channels for water to pipe embankment materials through the dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

No regulating procedures exist for the structure.

4.2 MAINTENANCE

According to Mr. Clarence Houk, the Baroid general superintendent, the spillway is periodically cleaned out and inspected after storms. A rock berm was installed at the toe to buttress the dam at some unknown date.

4.3 MAINTENANCE OF OPERATING FACILITIES

Not applicable.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect at this dam.

4.5 EVALUATION

A periodic inspection program should be established so that indications of instability, such as cracks in the dam, sloughing, sudden settlement, erosion of the dam, or an increase in the volume or turbidity of water from seepage can be monitored; in particular, the spring at Station 11+27 and the condition of both spillways should be observed regularly. Maintenance of the dam is inadequate.

SECTION 5 - HYDRAULIC AND HYDROLOGIC ANALYSES

5.1 EVALUATION OF FEATURES

a. Design Data. The significant dimensions of the dam, spillway, and the outlet pipes are presented in Section 1 - Project Information, and also presented in the accompanying field survey drawings, Plates 3 through 6. No hydrologic or hydraulic design information is available.

For this evaluation the watershed drainage area was obtained from the 1937 7.5-minute USGS Tiff Quadrangle. Stream lengths and reservoir areas were obtained from a 1971 ASCS aerial photograph enlargement (scale: 1-inch = 660 feet). The soil group for this watershed is classified as Goss Cherty Silt Loam, equivalent to a hydrologic soil group B classification, which has a moderate rate of water transmission.

The total drainage area at the Bottom Diggins Dam, Mo. I.D. 30750, is 1,110 acres (1.73 square miles). The watershed, subareas, and drainage boundaries are shown on Plate 2. The watershed is divided into two subareas by a road embankment. Separate ponds upstream and downstream of this road were observed during the field inspection. The upstream pond has been identified by the Corps of Engineers as MO 30752. The two subareas of the watershed are as follows:

Subarea	Drainage Area (Acres)
1. Watershed above Road Embankment	690
2. Drainage Area between the Upstream Road Embankment and the Bottom Diggins Dam	420

Land use and vegetation pattern on the watershed were determined from field observations and aerial photographs of the area. The type of land cover and land use were used to estimate runoff curve numbers (CN) for the antecedent moisture condition (AMC), which in turn, determine the amount of infiltration, retention losses and net runoff.

The design data, information, and assumptions used in the hydrologic and hydraulic analyses for each Subarea are individually discussed below. Basin parameters such as lag time, unit hydrograph, probable maximum precipitation, losses and net runoff for each Subarea are shown in Appendix A.

Subarea 1 - Watershed above Road Embankment

The drainage area above the road embankment is 690 acres (1.08 square miles). The watershed can be divided into the following types of land use and vegetation cover:

Type of Cover	Percent of Cover
Undisturbed Forest	61
Pasture/Grass	14
Strip Mined Area	22
Reservoir	3

The estimated runoff curve numbers (CN) weighted according to the above land cover distribution are CN 52 for the AMC II condition, and CN 71 for the AMC III condition.

The outlet for the storage pond of this Subarea is a 36-inch corrugated metal pipe culvert underneath the road embankment approximately 1400 feet southeast of the pond. The water flows from the pond through a swampy area passing through the culvert into the lower drainage area. The outlet of the culvert was observed under the existing water surface during the field investigation. The inlet to this culvert had partially collapsed to about half of the pipe opening. Flows through the culvert were computed assuming the pipe flow condition. A constant water surface level of El. 844.9 at the tailwater for the culvert was assumed. The length of the culvert is approximately 25 feet long; the friction head loss of the culvert was computed using a friction coefficient corresponding to a Manning "n" of 0.02. Computations of flows over the top of the road embankment (minimum elevation 846.5) were made by using the weir formula with a weir coefficient of 2.7. The combined discharge rating curve for the upstream pond is shown in Appendix A, under the input data listing as Y4 and Y5 cards, and also in the computer printout.

The reservoir elevation-area-capacity data are shown in Appendix A. The capacities, as computed in the computer program by the Conic Method, are the relative capacities above the estimated bottom elevation 840. The water surface areas at various elevations include both the pond area and the swamp area. They were estimated from the aerial photograph and field investigations.

Subarea 2 - Drainage Area Between the Upstream Road Embankment and the Bottom Diggins Dam

The incremental drainage area above the Bottom Diggins Dam is about 420 acres (0.66 square mile). Land use and type of land cover within this Subarea are as follows:

Type of Cover	Percent of Cover
Undisturbed Forest	52
Strip Mined Area	24
Old Tailings (Barite)	11
Reservoir	13

The estimated runoff curve numbers are AMC II, CN 56, and AMC III, CN 75.

There are two outlets for the lower reservoir - the left abutment spillway channel and the breach section. The cross-sections and profiles for both outlets and dam embankment are shown in Plates 3 through 6 based on field surveys and investigations.

1. Spillway Channel - The spillway channel is located between dam baseline Stations 0+00 and 0+50. Two cross-sections near the entrance of the spillway channel at baseline Station 0+30 were surveyed as shown on Plate 4. A narrower cross-section downstream of the entrance where the channel slope changes abruptly (Spillway Profile Sta. 2+15±) was also estimated (see also Plate 4). Our analysis indicates that the flow will be controlled by the downstream cross-section at Spillway Sta. 2+15. Flows over the spillway of various water levels were computed by the critical flow formula at this control section using the invert elevation the same as those at the two other upstream sections, El. 842.3.

2. Breach Section - The breach section is located south of the dam starting at Station 18+88. Two cross-sections within the reach of the breach were surveyed as shown on Plates 3 through 6. Flows over the two cross-sections were computed by the Manning formula using a Manning "n" of 0.05 and a channel slope of 0.01 estimated from field observations. The discharge rating curve computed from the crosssection shown on the dam baseline (see Plate 4C) was adopted since the flow computed from this section was smaller and controlled the flow. The invert elevation of the cross-section was taken to be the same as that of the upper cross-section at El. 842.3.

Flows over the dam crest (minimum crest elevation 847.1) were computed by the weir formula using a weir coefficient of 2.7. The combined discharge rating curve from the spillway channel, the breach section, and the lowest dam crest section is shown in Appendix A, under the input data listing as Y4 and Y5 cards of the lower pond, and also in the computer printouts.

The reservoir elevation-area-capacity data as shown in Appendix A were computed by the Conic Method. The computed capacities are relative capacity above the estimated bottom elevation 838.0. Water surface areas at various elevations were estimated from the 1971 ASCS aerial photograph enlargement and field investigations.

b. <u>Experience Data</u>. Recorded rainfall, runoff, or other experience data are not available.

c. <u>Visual Observations</u>. Visual observations are described in Section 3 - Visual Inspections.

d. <u>Overtopping Potential</u>. An analysis on the overtopping potential at the Bottom Diggins Dam was made using the following procedures:

- The 10-year and 100-year floods, probable maximum flood (PMF), and floods expressed as percentages of PMF were computed for both Subareas.

- Route floods through Subarea 1, the upper pond above the road embankment.

- Combine the routed outflows from Subarea 1 with the computed inflows from Subarea 2.

- Route the combined floods through the lower pond of the Bottom Diggins Dam. Results indicated that for floods larger than 32 percent of PMF, the water surface elevation of the Bottom Diggins Reservoir will be higher than El. 846.5 which is the lowest elevation of the upper road embankment. Once the water surface elevation of the lower pond reaches El. 846.5, the upper pond and lower pond merge into a single reservoir.

- For floods larger than 32 percent of PMF, a single reservoir was assumed. A combined reservoir elevation-storage relationship was established to consider the simultaneous storage effect of both upper and lower ponds. The computed inflows from both Subareas were then combined and routed directly through the overflow sections of the Bottom Diggins Dam to determine the overtopping potential.

The PMF is defined as the hypothetical flood event that would result from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible at a particular location or region. The Modified Puls Method was used for reservoir routing. For the 10-year and the 100-year floods, and floods of less than 32 percent PMF, the initial water level of the upper pond was set at El. 845 corresponding to the existing water surface elevation behind the road embankment, and the initial water level of the lower pond at El. 842.3 corresponding to the invert elevation of both the spillway channel and the breach section. For floods larger than 32 percent of PMF, the initial water level of the combined reservoir was set at El. 842.3. It was assumed that erosion of the road embankment of the upper pond, spillway channel and breach section of the lower pond will not occur as flood discharge increases. Therefore, the discharge rating curves for both ponds were computed for a certain specific cross-section and configuration.

Results of the overtopping analyses indicate that the spillway and the breach section are able to pass the 10-year and the 100-year floods. Routing studies indicate that both outflow sections can also pass 42 percent of the PMF without overtopping the embankment. At 42 percent PMF, the combined peak outflow is 2,700 cfs. The flow depth of the breach section is 4.1 feet and flow velocity is 6.5 feet per second. The corresponding flow depth at the spillway control section is 3.4 feet with a flow velocity of 9.7 feet per second. High discharge velocities such as those at 42 percent PMF peak outflow would cause significant erosion at both outflow sections.

A major consideration in evaluating the safety of the dam is assessing the potential for erosion failure of the embankment as a result of overtopping or discharges through the outflow sections. Since these outflow sections are composed of erodible materials, high velocity discharges

through them will lead to significant erosion even if the dam is not overtopped. Based on the Corps of Engineers Manual EM 1110-2-1601, "Hydraulic Design of the Flood Control Channels", the maximum permissible mean velocity for the residual soils found in the spillway section and the breach section is estimated to be about 4.0 feet per second. Using this as a criterion, the spillway control section can pass 3 percent of the PMF and the 10-year flood without significant erosion, while the breach section can pass the 10-year and 100-year floods, and about 13 percent of the PMF.

The results of the overtopping analyses are reported in Appendix A and summarized on the following page.

				Spillway				Breach Section			
Flood	Peak Inflow (cfs)	Total Peak Outflow (cfs)	Max. Res. WS Elev. (ft)	Peak Outflow (cfs)	Flow Depth (ft)	Flow Velocity (ft/sec)	Duration Velocity Over 4 ft/sec (hr)	Peak Outflow (cfs)	Flow Depth (ft)	Flow Velocity (ft/sec)	Duration Velocity Over 4 ft/sec (hr)
3% PMF	125	63	843.0	23	0.4	3.7	-	40	0.6	1.9	-
15% PMF	1,161	798	845.0	180	1.8*	7.3*	11.5	618	2.1*	4.2*	2.3
32% PMF	2,494	2,069	846.5	370	3.0*	9.1*	15.0	1,699	3.5*	5.9*	5.5
35% PMF	2,746	2,251	846.7	400	3.1*	9.3*	16.5	1,851	3.6*	6.0*	5.8
50% PMF	3,923	3,259	847.5	530	3.6**	10.0**	19.0	2,620	4.5**	7.0**	7.0
PMF	7,846	7,360	849.2	850	4.9**	11.4**	22.0	4,690	5.9**	8.6**	9.5
100-yr	451	259	843.7	70	0.9*	5.4*	11.0	189	1.2	3.0	-

* These flow depths and velocities are considered to produce the effects of significant erosion.

** Dam overtopped (Minimum Dam Crest El. 847.1).

Note: Reservoir water surface elevations include the velocity heads corresponding to the velocities computed at the various flow depths for the spillway and breach sections.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which adversely affect the structural stability of the dam are discussed in Section 3.

b. Design and Construction Data. No design, construction data, seepage or stability analyses were available for this dam. Construction practices used are described in Section 2.

c. Operating Records. No appurtenant structures are operable at this dam; no records of operations were located.

d. Post Construction Changes. The dam has been enlarged during active mine operations, but no records are available concerning dates of enlargements, design, or materials used. A rock toe berm was constructed to buttress and drain the toe of the dam at an unknown date.

e. Seismic Stability. The dam is located in Seismic Zone 2, which the 1976 Uniform Building Code assigns a "moderate" damage potential. There appears to be a potential for instability caused by ground shaking during earthquakes where the dam overlies soft saturated clay foundation soil. Some crest settlement and ravelling of the embankment gravels could also occur during seismic shaking because the downstream slope is at or near the natural angle of repose of the gravel.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several deficient conditions at the dam should be corrected to improve the margin of safety for embankment stability. Soft foundation conditions and seepage at the dam toe is the most serious deficiency. Other deficiencies noted are: serious wave erosion on the upstream slope, lack of erosion protection in the spillway, animal burrows and dead trees on the dam. The soft foundation conditions caused by seepage could reduce the stability of the dam. Suggested remedial measures are discussed in Section 7.2 REMEDIAL MEASURES.

b. Adequacy of Information. No design or construction data were available. Seepage and stability analyses meeting the requirements of "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

Topographic mapping for this dam is inadequate. This is due primarily to the fact that no topographic relief of the dam and reservoir is shown on the 1937 USGS 7.5-minute quadrangle map. The drainage area measurement was made after locating the dam on the original topography. Reservoir area-capacity data and slopes were developed using survey measurements and constructing topographic contours on a 1" = 660' air photo enlargement showing the reservoir and watershed areas. This data is considered sufficient for a Phase I analysis; however, the evaluation of overtopping potential is approximate due to the available data.

c. Urgency. The soft foundation conditions and extensive seepage and interrupted drainage at the dam toe is a serious deficiency. Corrective measures should be initiated immediately without delay.

d. Additional Investigations. Additional investigations should be completed as necessary so that seepage and stability analyses can be performed. The investigations should be undertaken by an engineer experienced in the design and construction of tailings dams. Also, the size and complexity of the watershed indicates a need for more detailed analysis and topographic mapping to determine spillway requirements for this dam.

7.2 REMEDIAL MEASURES

a. Spillway. Adequate spillway capacity should be provided to safely pass the PMF without causing erosion of the spillway or embankment under the guidelines established by the Corps of Engineers. Erosion protection should be placed in the left abutment spillway to prevent further erosion of the channel walls. This work should be accomplished under the direction of an engineer experienced in the design and construction of dams.

b. Drainage of Water. Water which presently ponds at the dam toe should be drained to remove water which could saturate and weaken foundation soil. The water impounded in the reservoir should be completely drained to reduce this source of seepage water.

c. Stability and Seepage Analyses. These analyses should be performed by an engineer experienced in the design and construction of tailings dams. The embankment could be a relatively porous granular structure at high water elevations. If the impoundment level were to rise to levels near the crest, there could be significant seepage through the embankment which could adversely affect the stability of the dam. Included in these analyses, therefor, seepage and stability computations should be performed with the reservoir water surface set at the top of the dam. The results of these studies may indicate that other remedial measures are required. All such remedial measures should be accomplished under the direction of an engineer experienced in the design and construction of tailings dams.

d. Slope Protection. The beach erosion, dead trees, and animal burrows on the upstream slope should be repaired or removed and adequate slope protection material installed to prevent further erosion. Trees and brush growing on the downstream slope should be removed to allow observation of conditions at the toe. This work should be accomplished under the direction of an engineer experienced in the design and construction of dams.

e. Breach Spillway. Access to the dam during storm events should be insured by channeling outflow and providing a passable road crossing over this channel. Erosion protection should be provided to stabilize the slopes forming the breach.

f. Inspection Program. The dam should be inspected periodically by an engineer who will observe and record the performance of the dam. The springs and seeps should be monitored as part of the inspection program. Records of these inspections should be maintained, and all maintenance or remedial measures performed at the site should be documented.

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSES

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSES

The hydrologic and hydraulic analyses were accomplished by using the computer program "Flood Hydrograph Package, HEC-1, Dam Safety Investigations Version, July 1978". This program was developed by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The criteria and methodology used are briefly discussed below:

- Probable Maximum Precipitation (PMP) - The 24-hour PMP was obtained from Hydrometeorological Report No. 33. The 6-hour and the 1-hour depth-duration distributions followed Corps of Engineers EM 1110-2-1411 criteria.

- 100-year and/or 10-year storms - The 24-hour storm amounts and distributions were supplied by Corps of Engineers, St. Louis District, Missouri.

- Unit Hydrograph - The Soil Conservation Service (SCS) curvelinear unit hydrograph method was used. Basin lag time was computed by using the SCS Curve Number Method and equation.

- Hydrologic Soil Group, Antecedent Moisture Condition (AMC) and Curve Number (CN) - The predominant hydrologic soil group for the watershed was obtained from an agricultural soil classification map prepared by the University of Missouri Agricultural Experiment Station. For the PMF and floods expressed as a percent of PMF, AMC III conditions were used. For the 100-year and/or 10-year floods, AMC II conditions were assumed. Watershed CN was estimated from field observations and from aerial photos.

- Reservoir Area-Capacity - Areas were measured from a 1971 ASCS aerial photograph enlargement (scale: 1-inch = 660 feet). Reservoir elevations and corresponding surface areas were input in the computer program, which determined the reservoir capacities by the Conic Method.

- Reservoir and Spillway Flood Routing - The Modified Puls Method was used for all flood routing through spillway and dam overtopping analyses.

The following pages present the input data listing, the computer program version and its last modification date, together with pertinent computer printouts of results. Definitions of all input and output variable names are presented in the computer program "Users Manual", September 1978, and are not explained herein.

```
A1        BOTTOM DIGGINS DAM MO. NO. 30750
A2        HEC-1  PHASE 1  DAM SAFETY INVESTIGATION
A3        RATIOS OF PMF
B      200              15                                                       2
B1       5
J        1       3       1
J1     .03     .15     .32
K        0  RUNOFF                                               1
K1  INFLOW FROM UPPER WATERSHED
M        1       2   1.078                                1
P             25.8     102     120     130
T                                                       -1     -71             .029
W2            1.15
X      -10     -.1     2.5
K        1  U POND                                               1
K1  PMF RATIOS ROUTING THROUGH UPPER POND (CULVERT)
Y                                1       1
Y1       1                                            -845      -1
Y4   844.9   845.0   845.5   846.0   846.5   847.0   847.5   848.0   848.5   849.0
Y5       0      11      26      36      43     126     491    1238    2495    4376
$A       0     6.7     9.3    12.5    14.0    15.4    16.2    17.2    20.0    22.5
$A    25.8
$E     840     841     842     844     845     846   846.5     847     848     849
$E     850
$$   846.5
$D   846.5
K        0  RUNOFF                                               1
K1  INFLOW FROM LOWER WATERSHED
M        1       2    .656                                1                      1
P             25.8     102     120     130
T                                                       -1     -75             .131
W2            1.22
X      -10     -.1     2.5
```

```
K        2  UP+LOW
K1   COMBINATION OF OUTFLOW FROM UPPER LAKE AND RUNOFF FROM LOWER WATERSHED
K        1  L POND
K1   PMF RATIOS, ROUTING THROUGH LOWER POND
Y                                            1         1
Y1       1                                                         -842.3        -1
Y4  842.3     843.0     843.5     844.0     845.0     845.5     846.0     847.1     848.0     849.0
Y5      0        66       182       345       809      1110      1520      2700      3873      6510
$A     33        49        54        58        62        64        66        68        70        72
$E    842       843       844       845       846     846.5       847       848       849       850
$$  842.3
$D  847.1
K      99
A
A
A
A
A
```

```
********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
 LAST MODIFICATION  26 FEB 79
********************************

RUN  DATE* 79/10/17.
     TIME* 09.32.11.


                        BOTTOM DIGGINS DAM MO. NO. 30750
                        HEC-1  PHASE 1  DAM SAFETY INVESTIGATION
                        RATIOS OF PMF

                                        JOB SPECIFICATION
        NQ       NHR      NMIN      IDAY      IHR      IMIN     METRC      IPLT      IPRT     NSTAN
       200         0        15         0        0         0         0         0         2         0
                                   JUPER      NWT     LROPT     TRACE
                                       5        0         0         0

                                 MULTI-PLAN ANALYSES TO BE PERFORMED
                                    NPLAN= 1 NRTIO= 3 LRTIO= 1
         RTIOS=     .03     .15     .32


**********          **********          **********          **********          **********

                                     SUB-AREA RUNOFF COMPUTATION

    INFLOW FROM UPPER WATERSHED

                     ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME  ISTAGE    IAUTO
                    RUNOFF        0        0        0        0        0        1       0        0

                                        HYDROGRAPH DATA
     IHYDG     IUHG    TAREA     SNAP    TRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
         1        2     1.08     0.00     1.08     1.00    0.000        0        0        0

                                          PRECIP DATA
                 SPFE      PMS       R6      R12      R24      R48      R72      R96
                 0.00    25.80   102.00   120.00   130.00     0.00     0.00     0.00

                                           LOSS DATA
    LROPT    STRKR    DLTKR    RTIOL    ERAIN    STRKS    RTIOK    STRTL    CNSTL    ALSMX    RTIMP
        0     0.00     0.00     1.00     0.00     0.00     1.00    -1.00   -71.00     0.00      .03

       CURVE NO =  -71.00  WETNESS =   -1.00  EFFECT CN =   71.00

                                       UNIT HYDROGRAPH DATA
                                  TC=  0.00      LAG=  1.15

                                         RECESSION DATA
                            STRTQ=  -10.00      QRCSN=     -.10      RTIOR= 2.50

      UNIT HYDROGRAPH 25 END OF PERIOD ORDINATES, TC=    0.00 HOURS, LAG=   1.15   VOL= 1.00
    40.       123.       260.       373.       408.       386.       328.       244.       169.       122.
    91.        66.        48.        35.        25.        18.        13.        10.         7.         5.
```

4.   3.   2.   1.   0.

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.15	1	.04	.00	.04	10.	1.02	1.15	101	0.00	0.00	0.00	127.
1.01	.30	2	.04	.00	.04	9.	1.02	1.30	102	0.00	0.00	0.00	116.
1.01	.45	3	.04	.00	.04	9.	1.02	1.45	103	0.00	0.00	0.00	106.
1.01	1.00	4	.04	.00	.04	8.	1.02	2.00	104	0.00	0.00	0.00	96.
1.01	1.15	5	.04	.00	.04	8.	1.02	2.15	105	0.00	0.00	0.00	88.
1.01	1.30	6	.04	.00	.04	8.	1.02	2.30	106	0.00	0.00	0.00	80.
1.01	1.45	7	.04	.00	.04	8.	1.02	2.45	107	0.00	0.00	0.00	73.
1.01	2.00	8	.04	.00	.04	8.	1.02	3.00	108	0.00	0.00	0.00	67.
1.01	2.15	9	.04	.00	.04	8.	1.02	3.15	109	0.00	0.00	0.00	61.
1.01	2.30	10	.04	.00	.04	7.	1.02	3.30	110	0.00	0.00	0.00	56.
1.01	2.45	11	.04	.00	.04	7.	1.02	3.45	111	0.00	0.00	0.00	51.
1.01	3.00	12	.04	.00	.04	7.	1.02	4.00	112	0.00	0.00	0.00	46.
1.01	3.15	13	.04	.00	.04	7.	1.02	4.15	113	0.00	0.00	0.00	42.
1.01	3.30	14	.04	.00	.04	6.	1.02	4.30	114	0.00	0.00	0.00	39.
1.01	3.45	15	.04	.00	.04	6.	1.02	4.45	115	0.00	0.00	0.00	35.
1.01	4.00	16	.04	.00	.04	6.	1.02	5.00	116	0.00	0.00	0.00	32.
1.01	4.15	17	.04	.00	.04	6.	1.02	5.15	117	0.00	0.00	0.00	29.
1.01	4.30	18	.04	.00	.04	6.	1.02	5.30	118	0.00	0.00	0.00	27.
1.01	4.45	19	.04	.00	.04	5.	1.02	5.45	119	0.00	0.00	0.00	24.
1.01	5.00	20	.04	.00	.04	5.	1.02	6.00	120	0.00	0.00	0.00	22.
1.01	5.15	21	.04	.00	.04	5.	1.02	6.15	121	0.00	0.00	0.00	20.
1.01	5.30	22	.04	.00	.04	5.	1.02	6.30	122	0.00	0.00	0.00	19.
1.01	5.45	23	.04	.00	.04	6.	1.02	6.45	123	0.00	0.00	0.00	17.
1.01	6.00	24	.04	.00	.04	6.	1.02	7.00	124	0.00	0.00	0.00	15.
1.01	6.15	25	.19	.03	.16	8.	1.02	7.15	125	0.00	0.00	0.00	14.
1.01	6.30	26	.19	.04	.15	13.	1.02	7.30	126	0.00	0.00	0.00	13.
1.01	6.45	27	.19	.06	.14	24.	1.02	7.45	127	0.00	0.00	0.00	12.
1.01	7.00	28	.19	.07	.13	40.	1.02	8.00	128	0.00	0.00	0.00	11.
1.01	7.15	29	.19	.08	.12	61.	1.02	8.15	129	0.00	0.00	0.00	10.
1.01	7.30	30	.19	.08	.11	86.	1.02	8.30	130	0.00	0.00	0.00	9.
1.01	7.45	31	.19	.09	.10	113.	1.02	8.45	131	0.00	0.00	0.00	8.
1.01	8.00	32	.19	.10	.09	140.	1.02	9.00	132	0.00	0.00	0.00	7.
1.01	8.15	33	.19	.10	.09	165.	1.02	9.15	133	0.00	0.00	0.00	7.
1.01	8.30	34	.19	.11	.08	190.	1.02	9.30	134	0.00	0.00	0.00	6.
1.01	8.45	35	.19	.12	.08	213.	1.02	9.45	135	0.00	0.00	0.00	6.
1.01	9.00	36	.19	.12	.07	234.	1.02	10.00	136	0.00	0.00	0.00	5.
1.01	9.15	37	.19	.12	.07	254.	1.02	10.15	137	0.00	0.00	0.00	5.
1.01	9.30	38	.19	.13	.07	272.	1.02	10.30	138	0.00	0.00	0.00	4.
1.01	9.45	39	.19	.13	.06	289.	1.02	10.45	139	0.00	0.00	0.00	4.
1.01	10.00	40	.19	.13	.06	304.	1.02	11.00	140	0.00	0.00	0.00	4.
1.01	10.15	41	.19	.14	.06	318.	1.02	11.15	141	0.00	0.00	0.00	3.
1.01	10.30	42	.19	.14	.05	331.	1.02	11.30	142	0.00	0.00	0.00	3.
1.01	10.45	43	.19	.14	.05	343.	1.02	11.45	143	0.00	0.00	0.00	3.
1.01	11.00	44	.19	.15	.05	354.	1.02	12.00	144	0.00	0.00	0.00	2.
1.01	11.15	45	.19	.15	.05	364.	1.02	12.15	145	0.00	0.00	0.00	2.
1.01	11.30	46	.19	.15	.04	373.	1.02	12.30	146	0.00	0.00	0.00	2.
1.01	11.45	47	.19	.15	.04	382.	1.02	12.45	147	0.00	0.00	0.00	2.
1.01	12.00	48	.19	.15	.04	390.	1.02	13.00	148	0.00	0.00	0.00	2.
1.01	12.15	49	.66	.53	.12	412.	1.02	13.15	149	0.00	0.00	0.00	2.
1.01	12.30	50	.66	.55	.11	466.	1.02	13.30	150	0.00	0.00	0.00	1.
1.01	12.45	51	.66	.56	.10	573.	1.02	13.45	151	0.00	0.00	0.00	1.
1.01	13.00	52	.66	.57	.08	726.	1.02	14.00	152	0.00	0.00	0.00	1.
1.01	13.15	53	.79	.70	.09	900.	1.02	14.15	153	0.00	0.00	0.00	1.
1.01	13.30	54	.79	.71	.08	1080.	1.02	14.30	154	0.00	0.00	0.00	1.
1.01	13.45	55	.79	.72	.07	1256.	1.02	14.45	155	0.00	0.00	0.00	1.

1.01	14.00	56	.79	.73	.06	1416.
1.01	14.15	57	.99	.92	.07	1561.
1.01	14.30	58	.99	.93	.06	1699.
1.01	14.45	59	.99	.93	.05	1844.
1.01	15.00	60	.99	.94	.05	1990.
1.01	15.15	61	1.00	.96	.04	2126.
1.01	15.30	62	2.00	1.92	.08	2285.
1.01	15.45	63	5.60	5.45	.15	2647.
1.01	16.00	64	1.40	1.37	.03	3250.
1.01	16.15	65	.92	.90	.02	4070.
1.01	16.30	66	.92	.90	.02	4705.
1.01	16.45	67	.92	.91	.02	4907.
1.01	17.00	68	.92	.91	.01	4772.
1.01	17.15	69	.72	.71	.01	4411.
1.01	17.30	70	.72	.71	.01	3910.
1.01	17.45	71	.72	.71	.01	3438.
1.01	18.00	72	.72	.71	.01	3088.
1.01	18.15	73	.06	.06	.00	2796.
1.01	18.30	74	.06	.06	.00	2496.
1.01	18.45	75	.06	.06	.00	2158.
1.01	19.00	76	.06	.06	.00	1792.
1.01	19.15	77	.06	.06	.00	1438.
1.01	19.30	78	.06	.06	.00	1123.
1.01	19.45	79	.06	.06	.00	864.
1.01	20.00	80	.06	.06	.00	671.
1.01	20.15	81	.06	.06	.00	536.
1.01	20.30	82	.06	.06	.00	468.
1.01	20.45	83	.06	.06	.00	427.
1.01	21.00	84	.06	.06	.00	389.
1.01	21.15	85	.06	.06	.00	355.
1.01	21.30	86	.06	.06	.00	324.
1.01	21.45	87	.06	.06	.00	296.
1.01	22.00	88	.06	.06	.00	270.
1.01	22.15	89	.06	.06	.00	246.
1.01	22.30	90	.06	.06	.00	225.
1.01	22.45	91	.06	.06	.00	205.
1.01	23.00	92	.06	.06	.00	187.
1.01	23.15	93	.06	.06	.00	181.
1.01	23.30	94	.06	.06	.00	180.
1.01	23.45	95	.06	.06	.00	178.
1.02	0.00	96	.06	.06	.00	177.
1.02	.15	97	0.00	0.00	0.00	175.
1.02	.30	98	0.00	0.00	0.00	167.
1.02	.45	99	0.00	0.00	0.00	152.
1.02	1.00	100	0.00	0.00	0.00	139.

1.02	15.00	156	0.00	0.00	0.00	1.
1.02	15.15	157	0.00	0.00	0.00	1.
1.02	15.30	158	0.00	0.00	0.00	1.
1.02	15.45	159	0.00	0.00	0.00	1.
1.02	16.00	160	0.00	0.00	0.00	1.
1.02	16.15	161	0.00	0.00	0.00	1.
1.02	16.30	162	0.00	0.00	0.00	0.
1.02	16.45	163	0.00	0.00	0.00	0.
1.02	17.00	164	0.00	0.00	0.00	0.
1.02	17.15	165	0.00	0.00	0.00	0.
1.02	17.30	166	0.00	0.00	0.00	0.
1.02	17.45	167	0.00	0.00	0.00	0.
1.02	18.00	168	0.00	0.00	0.00	0.
1.02	18.15	169	0.00	0.00	0.00	0.
1.02	18.30	170	0.00	0.00	0.00	0.
1.02	18.45	171	0.00	0.00	0.00	0.
1.02	19.00	172	0.00	0.00	0.00	0.
1.02	19.15	173	0.00	0.00	0.00	0.
1.02	19.30	174	0.00	0.00	0.00	0.
1.02	19.45	175	0.00	0.00	0.00	0.
1.02	20.00	176	0.00	0.00	0.00	0.
1.02	20.15	177	0.00	0.00	0.00	0.
1.02	20.30	178	0.00	0.00	0.00	0.
1.02	20.45	179	0.00	0.00	0.00	0.
1.02	21.00	180	0.00	0.00	0.00	0.
1.02	21.15	181	0.00	0.00	0.00	0.
1.02	21.30	182	0.00	0.00	0.00	0.
1.02	21.45	183	0.00	0.00	0.00	0.
1.02	22.00	184	0.00	0.00	0.00	0.
1.02	22.15	185	0.00	0.00	0.00	0.
1.02	22.30	186	0.00	0.00	0.00	0.
1.02	22.45	187	0.00	0.00	0.00	0.
1.02	23.00	188	0.00	0.00	0.00	0.
1.02	23.15	189	0.00	0.00	0.00	0.
1.02	23.30	190	0.00	0.00	0.00	0.
1.02	23.45	191	0.00	0.00	0.00	0.
1.03	0.00	192	0.00	0.00	0.00	0.
1.03	.15	193	0.00	0.00	0.00	0.
1.03	.30	194	0.00	0.00	0.00	0.
1.03	.45	195	0.00	0.00	0.00	0.
1.03	1.00	196	0.00	0.00	0.00	0.
1.03	1.15	197	0.00	0.00	0.00	0.
1.03	1.30	198	0.00	0.00	0.00	0.
1.03	1.45	199	0.00	0.00	0.00	0.
1.03	2.00	200	0.00	0.00	0.00	0.
		SUM	33.54	29.22	4.32	83020.
			(852.)(	742.)(	110.)(	2350.86)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4907.	2715.	861.	415.	83019.
CMS	139.	77.	24.	12.	2351.
INCHES		23.43	29.71	29.85	29.85
MM		595.06	754.72	758.18	758.18
AC-FT		1346.	1707.	1715.	1715.
THOUS CU M		1661.	2106.	2116.	2116.

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**********          **********          **********          **********          **********

                                 HYDROGRAPH ROUTING

          PMF RATIOS ROUTING THROUGH UPPER POND (CULVERT)

                   ISTAQ     ICOMP     IECON     ITAPE     JPLT      JPRT     INAME    ISTAGE     IAUTO
                  U POND         1         0         0        0         0         1        0         0
                                              ROUTING DATA
          QLOSS    CLOSS       AVG      IRES     ISAME     IOPT      IPMP                LSTR
            0.0    0.000      0.00         1         1        0         0                   0

                   NSTPS     NSTDL       LAG     AMSKK        X       TSK     STORA    ISPRAT
                       1         0         0     0.000    0.000     0.000     -845.       -1

STAGE        844.90    845.00    845.50    846.00    846.50    847.00    847.50    848.00    848.50    849.00

FLOW           0.00     11.00     26.00     36.00     43.00    126.00    491.00   1238.00   2895.00   4376.00

SURFACE AREA=      0.        7.        9.       13.       14.       15.       16.       17.       20.       23.
                  26.

CAPACITY=          0.        2.       10.       32.       45.       60.       68.       76.       95.      116.
                 140.

ELEVATION=       840.      841.      842.      844.      845.      846.      847.      847.      848.      849.
                 850.

                  CREL     SPWID      COQW      EXPW     ELEVL      COQL     CAREA      EXPL
                 846.5       0.0       0.0       0.0       0.0       0.0       0.0       0.0

                                          DAM DATA
                                 TOPEL      COQD      EXPD     DAMWID
                                 846.5       0.0       0.0         0.
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**********          **********          **********          **********          **********

                              SUB-AREA RUNOFF COMPUTATION

     INFLOW FROM LOWER WATERSHED

               ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
              RUNOFF       0       0       0       0       0       1       0       0

                                    HYDROGRAPH DATA
     IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
         1       2     .66    0.00     .66    1.00   0.000       0       1       0

                                      PRECIP DATA
             SPFE     PMS      R6     R12     R24     R48     R72     R96
             0.00   25.80  102.00  120.00  130.00    0.00    0.00    0.00

                                        LOSS DATA
   LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
       0    0.00    0.00    1.00    0.00    0.00    1.00   -1.00  -75.00    0.00     .13

     CURVE NO =  -75.00  WETNESS =   -1.00  EFFECT CN =   75.00

                                  UNIT HYDROGRAPH DATA
                               TC=  0.00     LAG=  1.22

                                     RECESSION DATA
                    STRTQ=  -10.00    QRCSN=    -.10    RTIOR= 2.50

     UNIT HYDROGRAPH 26 END OF PERIOD ORDINATES, TC=     0.00 HOURS, LAG=   1.22  VOL= 1.00
   21.       65.       136.       204.       234.       231.       202.       163.       115.       84.
   62.       47.        34.        25.        19.        14.        10.         8.         6.        4.
    3.        2.         2.         1.         1.         0.

 0                                      END-OF-PERIOD FLOW
MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q       MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q
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1.01	.15	1	.04	.01	.04	6.	1.02	1.15	101	0.00	0.00	0.00	78.
1.01	.30	2	.04	.01	.04	6.	1.02	1.30	102	0.00	0.00	0.00	71.
1.01	.45	3	.04	.01	.04	6.	1.02	1.45	103	0.00	0.00	0.00	65.
1.01	1.00	4	.04	.01	.04	7.	1.02	2.00	104	0.00	0.00	0.00	60.
1.01	1.15	5	.04	.01	.04	8.	1.02	2.15	105	0.00	0.00	0.00	54.
1.01	1.30	6	.04	.01	.04	9.	1.02	2.30	106	0.00	0.00	0.00	50.
1.01	1.45	7	.04	.01	.04	10.	1.02	2.45	107	0.00	0.00	0.00	45.
1.01	2.00	8	.04	.01	.04	10.	1.02	3.00	108	0.00	0.00	0.00	41.
1.01	2.15	9	.04	.01	.04	11.	1.02	3.15	109	0.00	0.00	0.00	38.
1.01	2.30	10	.04	.01	.04	11.	1.02	3.30	110	0.00	0.00	0.00	34.
1.01	2.45	11	.04	.01	.04	11.	1.02	3.45	111	0.00	0.00	0.00	31.
1.01	3.00	12	.04	.01	.04	11.	1.02	4.00	112	0.00	0.00	0.00	29.
1.01	3.15	13	.04	.01	.04	11.	1.02	4.15	113	0.00	0.00	0.00	26.
1.01	3.30	14	.04	.01	.04	11.	1.02	4.30	114	0.00	0.00	0.00	24.
1.01	3.45	15	.04	.01	.04	11.	1.02	4.45	115	0.00	0.00	0.00	22.
1.01	4.00	16	.04	.01	.04	11.	1.02	5.00	116	0.00	0.00	0.00	20.
1.01	4.15	17	.04	.01	.04	11.	1.02	5.15	117	0.00	0.00	0.00	18.
1.01	4.30	18	.04	.01	.04	11.	1.02	5.30	118	0.00	0.00	0.00	16.
1.01	4.45	19	.04	.01	.03	11.	1.02	5.45	119	0.00	0.00	0.00	15.
1.01	5.00	20	.04	.01	.03	11.	1.02	6.00	120	0.00	0.00	0.00	14.
1.01	5.15	21	.04	.01	.03	12.	1.02	6.15	121	0.00	0.00	0.00	13.
1.01	5.30	22	.04	.01	.03	12.	1.02	6.30	122	0.00	0.00	0.00	11.
1.01	5.45	23	.04	.01	.03	13.	1.02	6.45	123	0.00	0.00	0.00	10.
1.01	6.00	24	.04	.01	.03	14.	1.02	7.00	124	0.00	0.00	0.00	10.
1.01	6.15	25	.19	.06	.13	17.	1.02	7.15	125	0.00	0.00	0.00	9.
1.01	6.30	26	.19	.08	.12	21.	1.02	7.30	126	0.00	0.00	0.00	8.
1.01	6.45	27	.19	.09	.11	30.	1.02	7.45	127	0.00	0.00	0.00	7.
1.01	7.00	28	.19	.10	.10	44.	1.02	8.00	128	0.00	0.00	0.00	7.
1.01	7.15	29	.19	.10	.09	62.	1.02	8.15	129	0.00	0.00	0.00	6.
1.01	7.30	30	.19	.11	.08	81.	1.02	8.30	130	0.00	0.00	0.00	5.
1.01	7.45	31	.19	.12	.08	101.	1.02	8.45	131	0.00	0.00	0.00	5.
1.01	8.00	32	.19	.12	.07	120.	1.02	9.00	132	0.00	0.00	0.00	5.
1.01	8.15	33	.19	.13	.07	137.	1.02	9.15	133	0.00	0.00	0.00	4.
1.01	8.30	34	.19	.13	.06	152.	1.02	9.30	134	0.00	0.00	0.00	4.
1.01	8.45	35	.19	.14	.06	166.	1.02	9.45	135	0.00	0.00	0.00	3.
1.01	9.00	36	.19	.14	.05	179.	1.02	10.00	136	0.00	0.00	0.00	3.
1.01	9.15	37	.19	.14	.05	190.	1.02	10.15	137	0.00	0.00	0.00	3.
1.01	9.30	38	.19	.15	.05	201.	1.02	10.30	138	0.00	0.00	0.00	3.
1.01	9.45	39	.19	.15	.04	210.	1.02	10.45	139	0.00	0.00	0.00	2.
1.01	10.00	40	.19	.15	.04	218.	1.02	11.00	140	0.00	0.00	0.00	2.
1.01	10.15	41	.19	.15	.04	226.	1.02	11.15	141	0.00	0.00	0.00	2.
1.01	10.30	42	.19	.16	.04	233.	1.02	11.30	142	0.00	0.00	0.00	2.
1.01	10.45	43	.19	.16	.04	239.	1.02	11.45	143	0.00	0.00	0.00	2.
1.01	11.00	44	.19	.16	.03	244.	1.02	12.00	144	0.00	0.00	0.00	2.
1.01	11.15	45	.19	.16	.03	250.	1.02	12.15	145	0.00	0.00	0.00	1.
1.01	11.30	46	.19	.16	.03	254.	1.02	12.30	146	0.00	0.00	0.00	1.
1.01	11.45	47	.19	.16	.03	258.	1.02	12.45	147	0.00	0.00	0.00	1.
1.01	12.00	48	.19	.17	.03	262.	1.02	13.00	148	0.00	0.00	0.00	1.
1.01	12.15	49	.66	.57	.08	275.	1.02	13.15	149	0.00	0.00	0.00	1.
1.01	12.30	50	.66	.58	.07	304.	1.02	13.30	150	0.00	0.00	0.00	1.
1.01	12.45	51	.66	.59	.06	364.	1.02	13.45	151	0.00	0.00	0.00	1.
1.01	13.00	52	.66	.60	.06	452.	1.02	14.00	152	0.00	0.00	0.00	1.
1.01	13.15	53	.79	.73	.06	555.	1.02	14.15	153	0.00	0.00	0.00	1.
1.01	13.30	54	.79	.74	.05	665.	1.02	14.30	154	0.00	0.00	0.00	1.
1.01	13.45	55	.79	.74	.05	773.	1.02	14.45	155	0.00	0.00	0.00	1.
1.01	14.00	56	.79	.75	.04	874.	1.02	15.00	156	0.00	0.00	0.00	1.
1.01	14.15	57	.99	.94	.04	964.	1.02	15.15	157	0.00	0.00	0.00	0.
1.01	14.30	58	.99	.95	.04	1049.	1.02	15.30	158	0.00	0.00	0.00	0.
1.01	14.45	59	.99	.95	.03	1135.	1.02	15.45	159	0.00	0.00	0.00	0.
1.01	15.00	60	.99	.96	.03	1222.	1.02	16.00	160	0.00	0.00	0.00	0.

1.01	15.15	61	1.00	.97	.03	1304.	1.02	16.15	161	0.00	0.00	0.00	0.
1.01	15.30	62	2.00	1.95	.05	1398.	1.02	16.30	162	0.00	0.00	0.00	0.
1.01	15.45	63	5.60	5.50	.10	1600.	1.02	16.45	163	0.00	0.00	0.00	0.
1.01	16.00	64	1.40	1.38	.02	1929.	1.02	17.00	164	0.00	0.00	0.00	0.
1.01	16.15	65	.92	.91	.01	2375.	1.02	17.15	165	0.00	0.00	0.00	0.
1.01	16.30	66	.92	.91	.01	2766.	1.02	17.30	166	0.00	0.00	0.00	0.
1.01	16.45	67	.92	.91	.01	2939.	1.02	17.45	167	0.00	0.00	0.00	0.
1.01	17.00	68	.92	.91	.01	2914.	1.02	18.00	168	0.00	0.00	0.00	0.
1.01	17.15	69	.72	.72	.01	2739.	1.02	18.15	169	0.00	0.00	0.00	0.
1.01	17.30	70	.72	.72	.01	2485.	1.02	18.30	170	0.00	0.00	0.00	0.
1.01	17.45	71	.72	.72	.01	2187.	1.02	18.45	171	0.00	0.00	0.00	0.
1.01	18.00	72	.72	.72	.01	1960.	1.02	19.00	172	0.00	0.00	0.00	0.
1.01	18.15	73	.06	.06	.00	1772.	1.02	19.15	173	0.00	0.00	0.00	0.
1.01	18.30	74	.06	.06	.00	1591.	1.02	19.30	174	0.00	0.00	0.00	0.
1.01	18.45	75	.06	.06	.00	1388.	1.02	19.45	175	0.00	0.00	0.00	0.
1.01	19.00	76	.06	.06	.00	1170.	1.02	20.00	176	0.00	0.00	0.00	0.
1.01	19.15	77	.06	.06	.00	956.	1.02	20.15	177	0.00	0.00	0.00	0.
1.01	19.30	78	.06	.06	.00	760.	1.02	20.30	178	0.00	0.00	0.00	0.
1.01	19.45	79	.06	.06	.00	594.	1.02	20.45	179	0.00	0.00	0.00	0.
1.01	20.00	80	.06	.06	.00	463.	1.02	21.00	180	0.00	0.00	0.00	0.
1.01	20.15	81	.06	.06	.00	370.	1.02	21.15	181	0.00	0.00	0.00	0.
1.01	20.30	82	.06	.06	.00	302.	1.02	21.30	182	0.00	0.00	0.00	0.
1.01	20.45	83	.06	.06	.00	272.	1.02	21.45	183	0.00	0.00	0.00	0.
1.01	21.00	84	.06	.06	.00	248.	1.02	22.00	184	0.00	0.00	0.00	0.
1.01	21.15	85	.06	.06	.00	226.	1.02	22.15	185	0.00	0.00	0.00	0.
1.01	21.30	86	.06	.06	.00	207.	1.02	22.30	186	0.00	0.00	0.00	0.
1.01	21.45	87	.06	.06	.00	189.	1.02	22.45	187	0.00	0.00	0.00	0.
1.01	22.00	88	.06	.06	.00	172.	1.02	23.00	188	0.00	0.00	0.00	0.
1.01	22.15	89	.06	.06	.00	157.	1.02	23.15	189	0.00	0.00	0.00	0.
1.01	22.30	90	.06	.06	.00	143.	1.02	23.30	190	0.00	0.00	0.00	0.
1.01	22.45	91	.06	.06	.00	131.	1.02	23.45	191	0.00	0.00	0.00	0.
1.01	23.00	92	.06	.06	.00	119.	1.03	0.00	192	0.00	0.00	0.00	0.
1.01	23.15	93	.06	.06	.00	113.	1.03	.15	193	0.00	0.00	0.00	0.
1.01	23.30	94	.06	.06	.00	111.	1.03	.30	194	0.00	0.00	0.00	0.
1.01	23.45	95	.06	.06	.00	110.	1.03	.45	195	0.00	0.00	0.00	0.
1.02	0.00	96	.06	.06	.00	109.	1.03	1.00	196	0.00	0.00	0.00	0.
1.02	.15	97	0.00	0.00	0.00	107.	1.03	1.15	197	0.00	0.00	0.00	0.
1.02	.30	98	0.00	0.00	0.00	103.	1.03	1.30	198	0.00	0.00	0.00	0.
1.02	.45	99	0.00	0.00	0.00	94.	1.03	1.45	199	0.00	0.00	0.00	0.
1.02	1.00	100	0.00	0.00	0.00	86.	1.03	2.00	200	0.00	0.00	0.00	0.

SUM	33.54	30.33	3.21	52322.
	(852.)	(770.)	(82.)	(1481.59)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2939.	1675.	541.	262.	52320.
CMS	83.	47.	15.	7.	1482.
INCHES		23.75	30.69	30.91	30.91
MM		603.32	779.43	785.20	785.20
AC-FT		831.	1073.	1081.	1081.
THOUS CU M		1025.	1324.	1333.	1333.

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COMBINE HYDROGRAPHS

COMBINATION OF OUTFLOW FROM UPPER LAKE AND RUNOFF FROM LOWER WATERSHED

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
UP+LOW	2	0	0	0	0	0	0	0

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HYDROGRAPH ROUTING

PMF RATIOS, ROUTING THROUGH LOWER POND

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
L POND	1	0	0	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-842.	-1

STAGE	842.30	843.00	843.50	844.00	845.00	845.50	846.00	847.10	848.00	849.00
FLOW	0.00	66.00	182.00	345.00	809.00	1110.00	1520.00	2700.00	3873.00	6510.00
SURFACE AREA=	33.	49.	54.	58.	62.	64.	66.	68.	70.	72.
CAPACITY=	0.	41.	92.	148.	208.	240.	272.	339.	408.	479.
ELEVATION=	842.	843.	844.	845.	846.	846.5	847.	848.	849.	850.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
842.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
847.1	0.0	0.0	0.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 .03	RATIO 2 .15	RATIO 3 .32
				RATIOS APPLIED TO FLOWS		
HYDROGRAPH AT	RUNOFF	1.08	1	147.	736.	1570.
		(2.79)	(	4.17)(	20.84)(	44.47)(
ROUTE TO	U POND	1.08	1	62.	724.	1554.
		(2.79)	(	1.75)(	20.50)(	44.00)(
HYDROGRAPH AT	RUNOFF	.66	1	88.	441.	94[illegible].
		(1.70)	(	2.50)(	12.48)(	26.63)(
2 COMBINED	UP+LOW	1.73	1	125.	1161.	2494.
		(4.49)	(	3.55)(	32.88)(	70.63)(
ROUTED TO	L POND	1.73	1	63.	798.	2069.
		(4.49)	(	1.80)(	22.59)(	58.57)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	845.00	846.50	846.50
STORAGE	45.	68.	68.
OUTFLOW	11.	43.	43.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.03	846.61	.11	70.	62.	2.25	18.75	0.00
.15	847.66	1.16	88.	724.	9.25	17.00	0.00
.32	848.13	1.63	97.	1554.	14.25	16.75	0.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	842.30	842.30	847.10
STORAGE	11.	11.	279.
OUTFLOW	0.	0.	2700.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.03	842.97	0.00	39.	63.	0.00	20.00	0.00
.15	844.94	0.00	147.	798.	0.00	18.00	0.00
.32	846.51	0.00	240.	2069.	0.00	17.50	0.00

```
A1          BOTTOM DIGGINS DAM MO. NO. 30750
A2          HEC-1  PHASE 1  DAM SAFETY INVESTIGATION
A3          RATIOS OF PMF
B      200              15                                              2
B1       5
J        1       3       1
J1     .35     .50     1.0
K        0  RUNOFF                                      1
K1   INFLOW FROM UPPER WATERSHED
M        1       2   1.078                      1
P             25.8     102     120     130
T                                                      -1     -71            .029
W2            1.15
X      -10     -.1     2.5
K        0  RUNOFF                                      1
K1   INFLOW FROM LOWER WATERSHED
M        1       2    .656                      1               1
P             25.8     102     120     130
T                                                      -1     -75            .131
W2            1.22
X      -10     -.1     2.5
K        2  UP+LOW
K1   COMBINATION OF RUNOFFS FROM UPPER AND LOWER WATERSHEDS
K        1  L POND
K1   PMF RATIOS, ROUTING THROUGH LOWER POND
Y                                1       1
Y1       1                                          -842.3      -1
Y4   842.3   843.0   843.5   844.0   844.5   845.0   845.5   846.0   846.5   847.1
Y4   847.5   848.0   848.5   849.0   849.5   850.0
Y5       0      66     182     345     551     809    1110    1520    2055    2700
Y5    3200    3895    5072    6510    8290   10660
$S       0      39      94     153     217     251     291     377     467
$E   842.3     843     844     845     846   846.5     847     848     849
$$   842.3
$D   847.1
K       99
A
A
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********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
********************************

RUN  DATE= 79/10/12.
     TIME= 10.36.25.


                    BOTTOM DIGGINS DAM MO. NO. 30750
                    HEC-1  PHASE 1  DAM SAFETY INVESTIGATION
                    RATIOS OF PMF

                                   JOB SPECIFICATION
          NQ      NHR     NMIN     IDAY     IHR     IMIN   METRC    IPLT     IPRT    NSTAN
         200        0       15        0       0        0       0       0        2        0
                                  JOPER     NWT    LROPT   TRACE
                                      5       0        0       0

                             MULTI-PLAN ANALYSES TO BE PERFORMED
                                   NPLAN= 1 NRTIO= 3 LRTIO= 1
           RTIOS=    .35     .50    1.00


      **********       **********       **********       **********       **********

                              SUB-AREA RUNOFF COMPUTATION

         INFLOW FROM UPPER WATERSHED

                       ISTAQ    ICOMP    IECON    ITAPE    JPLT     JPRT    INAME  ISTAGE   IAUTO
                      RUNOFF        0        0        0       0        0        1       0       0

                                            HYDROGRAPH DATA
         IHYDG     IUHG    TAREA     SNAP    TRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
             1        2     1.08     0.00     1.08     1.00    0.000        0        0        0

                                              PRECIP DATA
                    SPFE      PMS       R6      R12      R24      R48      R72      R96
                    0.00    25.80   102.00   120.00   13?.00     0.00     0.00     0.00

                                               LOSS DATA
      LROPT   STRKR    DLTKR    RTIOL    ERAIN    STRKS    RTIOK    STRTL    CNSTL    ALSMX    RTIMP
          0    0.00     0.00     1.00     0.00     0.00     1.00    -1.00   -71.00     0.00      .03

         CURVE NO =  -71.00  WETNESS =   -1.00  EFFECT CN =   71.00

                                         UNIT HYDROGRAPH DATA
                                       TC=  0.00     LAG=  1.15

                                             RECESSION DATA
                             STRTQ=  -10.00     QRCSN=    -.10     RTIOR= 2.50

        UNIT HYDROGRAPH 25 END OF PERIOD ORDINATES, TC=    0.00 HOURS, LAG=   1.15  VOL= 1.00
      40.       123.      260.      373.      408.      386.      328.      244.      169.      122.
      91.        66.       48.       35.       25.       18.       13.       10.        7.        5.
```

HYDROGRAPH AT STARUNOFF FOR PLAN 1, RTIO 3

10.	9.	9.	8.	8.	8.	8.	8.	8.	7.
7.	7.	7.	6.	6.	6.	6.	6.	5.	5.
5.	5.	6.	6.	8.	13.	24.	40.	61.	86.
113.	140.	165.	190.	213.	234.	254.	272.	289.	304.
318.	331.	343.	354.	364.	373.	382.	390.	412.	466.
573.	726.	900.	1080.	1256.	1416.	1561.	1699.	1844.	1990.
2126.	2285.	2647.	3250.	4070.	4705.	4907.	4772.	4411.	3910.
3438.	3088.	2796.	2496.	2158.	1792.	1438.	1123.	864.	671.
536.	468.	427.	389.	355.	324.	296.	270.	246.	225.
205.	187.	181.	180.	178.	177.	175.	167.	152.	139.
127.	116.	106.	96.	88.	80.	73.	67.	61.	56.
51.	46.	42.	39.	35.	32.	29.	27.	24.	22.
20.	19.	17.	15.	14.	13.	12.	11.	10.	9.
8.	7.	7.	6.	6.	5.	5.	4.	4.	4.
3.	3.	3.	2.	2.	2.	2.	2.	2.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4907.	2715.	861.	415.	83019.
CMS	139.	77.	24.	12.	2351.
INCHES		23.43	29.71	29.85	29.85
MM		595.06	754.72	758.18	758.18
AC-FT		1346.	1707.	1715.	1715.
THOUS CU M		1661.	2106.	2116.	2116.

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SUB-AREA RUNOFF COMPUTATION

INFLOW FROM LOWER WATERSHED

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
RUNOFF	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.66	0.00	.66	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.80	102.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-75.00	0.00	.13

CURVE NO = -75.00 WETNESS = -1.00 EFFECT CN = 75.00

HYDROGRAPH AT STARUNOFF FOR PLAN 1, RTIO 3

6.	6.	6.	7.	8.	9.	10.	10.	11.	11.
11.	11.	11.	11.	11.	11.	11.	11.	11.	11.
12.	12.	13.	14.	17.	21.	30.	44.	62.	81.
101.	120.	137.	152.	166.	179.	190.	201.	210.	218.
226.	233.	239.	244.	250.	254.	258.	262.	275.	304.
364.	452.	555.	665.	773.	874.	964.	1049.	1135.	1222.
1304.	1398.	1600.	1929.	2375.	2766.	2939.	2914.	2739.	2485.
2187.	1960.	1772.	1591.	1388.	1170.	956.	760.	594.	463.
370.	302.	272.	248.	226.	207.	189.	172.	157.	143.
131.	119.	113.	111.	110.	109.	107.	103.	94.	86.
78.	71.	65.	60.	54.	50.	45.	41.	38.	34.
31.	29.	26.	24.	22.	20.	18.	16.	15.	14.
13.	11.	10.	10.	9.	8.	7.	7.	6.	5.
5.	5.	4.	4.	3.	3.	3.	3.	2.	2.
2.	2.	2.	2.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2939.	1675.	541.	262.	52320.
CMS	83.	47.	15.	7.	1482.
INCHES		23.75	30.69	30.91	30.91
MM		603.32	779.43	785.20	785.20
AC-FT		831.	1073.	1081.	1081.
THOUS CU M		1025.	1324.	1333.	1333.

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COMBINE HYDROGRAPHS

COMBINATION OF RUNOFFS FROM UPPER AND LOWER WATERSHEDS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
UP+LOW	2	0	0	0	0	0	0	0

SUM OF 2 HYDROGRAPHS AT UP+LOW PLAN 1 RTIO 3

16.	15.	15.	15.	16.	17.	18.	18.	18.	18.
18.	18.	18.	17.	17.	17.	16.	16.	16.	16.
17.	18.	19.	21.	25.	35.	54.	84.	123.	167.
214.	259.	302.	342.	379.	413.	444.	473.	499.	522.
544.	564.	582.	598.	613.	627.	640.	652.	687.	770.
937.	1177.	1455.	1745.	2029.	2291.	2525.	2748.	2979.	3212.
3429.	3683.	4247.	5179.	6445.	7471.	7846.	7687.	7150.	6395.
5624.	5048.	4568.	4087.	3546.	2962.	2394.	1883.	1458.	1134.
906.	769.	699.	638.	582.	531.	484.	442.	403.	368.
336.	306.	294.	291.	288.	287.	282.	270.	246.	225.
205.	187.	171.	156.	142.	130.	118.	108.	99.	90.
82.	75.	68.	62.	57.	52.	47.	43.	39.	36.
33.	30.	27.	25.	23.	21.	19.	17.	16.	14.
13.	12.	11.	10.	9.	8.	8.	7.	6.	6.
5.	5.	4.	4.	4.	3.	3.	3.	3.	2.
2.	2.	2.	2.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7846.	4390.	1402.	677.	135339.
CMS	222.	124.	40.	19.	3832.
INCHES		23.55	30.08	30.25	30.25
MM		598.19	764.02	768.40	768.40
AC-FT		2177.	2780.	2796.	2796.
THOUS CU M		2685.	3429.	3449.	3449.

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HYDROGRAPH ROUTING

PMF RATIOS, ROUTING THROUGH LOWER POND

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
L POND	1	0	0	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-842.	-1

STAGE	842.30	843.00	843.50	844.00	844.50	845.00	845.50	846.00	846.50	847.10
	847.50	848.00	848.50	849.00	849.50	850.00				
FLOW	0.00	66.00	182.00	345.00	551.00	809.00	1110.00	1520.00	2055.00	2700.00
	3200.00	3895.00	5072.00	6510.00	8290.00	10660.00				

CAPACITY=	0.	39.	94.	153.	217.	251.	291.	377.	467.
ELEVATION=	842.	843.	844.	845.	846.	847.	847.	848.	849.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
842.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
847.1	0.0	0.0	0.

STATION L POND, PLAN 1, RATIO 3

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

1.	1.	2.	2.	2.	3.	3.	4.	4.	5.
5.	6.	6.	7.	7.	7.	8.	8.	8.	8.
9.	9.	9.	10.	10.	11.	12.	14.	17.	21.
27.	34.	43.	52.	63.	87.	115.	144.	172.	208.
245.	281.	314.	346.	381.	414.	443.	470.	497.	528.
577.	656.	766.	911.	1083.	1327.	1591.	1885.	2144.	2376.
2606.	2840.	3134.	3579.	4376.	5541.	6606.	7279.	7360.	7019.
6445.	5894.	5355.	4878.	4426.	3928.	3559.	3157.	2769.	2412.
2073.	1730.	1463.	1277.	1121.	1018.	928.	846.	773.	709.
650.	595.	547.	513.	483.	457.	434.	412.	392.	371.
359.	331.	314.	297.	280.	265.	247.	232.	217.	203.
189.	178.	169.	161.	152.	144.	136.	129.	121.	114.
108.	101.	95.	89.	84.	79.	74.	69.	66.	64.
62.	60.	59.	57.	55.	54.	52.	51.	49.	48.
46.	45.	43.	42.	41.	39.	38.	37.	36.	35.
34.	32.	31.	30.	29.	28.	28.	27.	26.	25.
24.	23.	22.	22.	21.	20.	20.	19.	18.	18.
17.	17.	16.	15.	15.	14.	14.	13.	13.	13.
12.	12.	11.	11.	11.	10.	10.	10.	9.	9.
9.	8.	8.	8.	7.	7.	7.	7.	6.	6.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 .35	RATIO 2 .50	RATIO 3 1.00
				RATIOS APPLIED TO FLOWS		
HYDROGRAPH AT	RUNOFF	1.08	1	1718.	2454.	4907.
	(	2.79)	(	48.64)(	69.48)(	138.96)(
HYDROGRAPH AT	RUNOFF	.66	1	1029.	1469.	2939.
	(	1.70)	(	29.13)(	41.61)(	83.22)(
2 COMBINED	UP+LOW	1.73	1	2746.	3923.	7846.
	(	4.49)	(	77.76)(	111.09)(	222.18)(
ROUTED TO	L POND	1.73	1	2251.	3259.	7360.
	(	4.49)	(	63.73)(	92.29)(	208.40)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	842.30	842.30	847.10
STORAGE	0.	0.	300.
OUTFLOW	0.	0.	2700.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.35	846.68	0.00	266.	2251.	0.00	17.50	0.00
.50	847.54	.44	338.	3259.	1.75	17.50	0.00
1.00	849.24	2.14	488.	7360.	4.50	17.25	0.00

```
A1          BOTTOM DIGGINS DAM MO. NO. 30750
A2          HEC-1  PHASE 1  DAM SAFETY INVESTIGATION
A3          100 YEAR FLOOD
B     100              30                                                   2
B1      5
J       1        1        1
J1      1
K       0   INFLOW                                          1
K1   100-YR INFLOW TO UPPER POND BASED ON SULLIVAN PRECIP. 30 MIN. INTERVALS
M       0        2    1.078
O      48
O1   .042     .042     .042     .042     .042     .042     .042     .042     .042     .042
O1   .042     .042     .084     .084     .084     .084     .084     .084     .132     .132
O1   .132     .186     .366    1.449    1.853     .366     .186     .132     .132     .132
O1   .084     .084     .084     .084     .084     .084     .042     .042     .042     .042
O1   .042     .042     .042     .042     .042     .042     .042     .042
T                                                            -1      -52              .029
W2             1.9
X     -10      -.1      2.5
K       1  U POND                                           1
K1   100-YR FLOOD ROUTING THROUGH UPPER POND (CULVERT)
Y                                1        1
Y1      1                                                  -845       -1
Y4  844.9    845.0    845.5    846.0    846.5    847.0    847.5    848.0    848.5    849.0
Y5      0       11       26       36       43      126      491     1238     2495     4376
$A      0      6.7      9.3     12.5     14.0     15.4     16.2     17.2     20.0     22.5
$E    840      841      842      844      845      846    846.5      847      848      849
$$  846.5
$D  846.5
K       0  RUNOFF                                           1
K1   100-YR INFLOW TO LOWER POND BASED ON SULLIVAN PRECIP. 30 MIN. INTERVALS
M       0        2    0.656
O     -48
T                                                            -1      -56              .131
W2            2.01
X     -10      -.1      2.5
```

```
K       2  UP+LOW                                                     1
K1  COMBINATION OF OUTFLOW FROM UPPER LAKE AND RUNOFF OF LOWER WATERSHED
K       1  L POND                                                     1
K1  100-YR FLOOD ROUTING THROUGH LOWER POND
Y                                 1       1
Y1      1                                               -842.3     -1
Y4  842.3   843.0   843.5   844.0   844.5   845.0   845.5   846.0   847.1   848.0
Y5      0      66     182     345     551     809    1110    1520    2700    3873
$A      0       7      17      33      49      54      62      64
$E    838     840     841     842     843     844     846   846.5
$$  842.3
$D  847.1
K      99
A
```

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********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
********************************

RUN  DATE* 79/10/22.
     TIME* 14.35.45.


              BOTTOM DIGGINS DAM MO. NO. 30750
              HEC-1  PHASE 1  DAM SAFETY INVESTIGATION
              100 YEAR FLOOD

                                 JOB SPECIFICATION
    NQ     NHR     NMIN    IDAY     IHR     IMIN   METRC    IPLT    IPRT   NSTAN
   100       0       30       0       0        0       0       0       2       0
                           JOPER     NWT    LROPT   TRACE
                               5       0        0       0

                          MULTI-PLAN ANALYSES TO BE PERFORMED
                             NPLAN= 1 NRTIO= 1 LRTIO= 1
   RTIOS=    1.00


**********          **********          **********          **********          **********

                             SUB-AREA RUNOFF COMPUTATION

      100-YR INFLOW TO UPPER POND BASED ON SULLIVAN PRECIP. 30 MIN. INTERVALS

               ISTAQ    ICOMP    IECON    ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
              INFLOW        0        0        0       0       0       1       0       0

                                   HYDROGRAPH DATA
      IHYDG    IUHG    TAREA    SNAP    TRSDA    TRSPC   RATIO   ISNOW   ISAME   LOCAL
          0       2     1.08    0.00     1.08     0.00   0.000       0       0       0

                                     PRECIP DATA
                               NP    STORM     DAJ     DAK
                               48     0.00    0.00    0.00
                                   PRECIP PATTERN
   .04     .04     .04     .04     .04     .04     .04     .04     .04     .04
   .04     .04     .08     .08     .08     .08     .08     .08     .13     .13
   .13     .19     .37    1.45    1.85     .37     .19     .13     .13     .13
   .08     .08     .08     .08     .08     .08     .04     .04     .04     .04
   .04     .04     .04     .04     .04     .04     .04     .04

                                      LOSS DATA
  LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
      0    0.00    0.00    1.00    0.00    0.00    1.00   -1.00  -52.00    0.00     .03

     CURVE NO =  -52.00   WETNESS =   -1.00  EFFECT CN =   52.00

                                UNIT HYDROGRAPH DATA
                           TC=  0.00     LAG=  1.90
```

RECESSION DATA

STRTQ= -10.00 QRCSN= -.10 RTIOR= 2.50

UNIT HYDROGRAPH 21 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 1.90 VOL= 1.00

31.	100.	197.	240.	230.	190.	129.	86.	60.	41.
28.	19.	13.	9.	6.	4.	3.	2.	1.	1.
0.									

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.30	1	.04	.00	.04	10.	1.02	1.30	51	0.00	0.00	0.00	28.
1.01	1.00	2	.04	.00	.04	9.	1.02	2.00	52	0.00	0.00	0.00	26.
1.01	1.30	3	.04	.00	.04	9.	1.02	2.30	53	0.00	0.00	0.00	24.
1.01	2.00	4	.04	.00	.04	8.	1.02	3.00	54	0.00	0.00	0.00	22.
1.01	2.30	5	.04	.00	.04	8.	1.02	3.30	55	0.00	0.00	0.00	20.
1.01	3.00	6	.04	.00	.04	7.	1.02	4.00	56	0.00	0.00	0.00	18.
1.01	3.30	7	.04	.00	.04	7.	1.02	4.30	57	0.00	0.00	0.00	16.
1.01	4.00	8	.04	.00	.04	7.	1.02	5.00	58	0.00	0.00	0.00	15.
1.01	4.30	9	.04	.00	.04	6.	1.02	5.30	59	0.00	0.00	0.00	14.
1.01	5.00	10	.04	.00	.04	6.	1.02	6.00	60	0.00	0.00	0.00	12.
1.01	5.30	11	.04	.00	.04	6.	1.02	6.30	61	0.00	0.00	0.00	11.
1.01	6.00	12	.04	.00	.04	5.	1.02	7.00	62	0.00	0.00	0.00	10.
1.01	6.30	13	[illegible]	[illegible]	[illegible]	5.	1.02	7.30	63	0.00	0.00	0.00	9.
1.01	7.00	14	[illegible]	[illegible]	[illegible]	5.	1.02	8.00	64	0.00	0.00	0.00	9.
1.01	7.30	15	[illegible]	[illegible]	[illegible]	5.	1.02	8.30	65	0.00	0.00	0.00	8.
1.01	8.00	16	[illegible]	[illegible]	[illegible]	5.	1.02	9.00	66	0.00	0.00	0.00	7.
1.01	8.30	17	[illegible]	[illegible]	[illegible]	5.	1.02	9.30	67	0.00	0.00	0.00	7.
1.01	9.00	18	[illegible]	[illegible]	[illegible]	5.	1.02	10.00	68	0.00	0.00	0.00	6.
1.01	9.30	19	.13	.00	.13	5.	1.02	10.30	69	0.00	0.00	0.00	5.
1.01	10.00	20	.13	.00	.13	5.	1.02	11.00	70	0.00	0.00	0.00	5.
1.01	10.30	21	.13	.00	.13	5.	1.02	11.30	71	0.00	0.00	0.00	5.
1.01	11.00	22	.12	[illegible]	[illegible]	6.	1.02	12.00	72	0.00	0.00	0.00	4.
1.01	11.30	23	.37	[illegible]	[illegible]	6.	1.02	12.30	73	0.00	0.00	0.00	4.
1.01	12.00	24	[illegible]	[illegible]	1.14	15.	1.02	13.00	74	0.00	0.00	0.00	3.
1.01	12.30	25	[illegible]	[illegible]	1.12	56.	1.02	13.30	75	0.00	0.00	0.00	3.
1.01	13.00	26	[illegible]	[illegible]	.14	137.	1.02	14.00	76	0.00	0.00	0.00	3.
1.01	13.30	27	[illegible]	[illegible]	[illegible]	234.	1.02	14.30	77	0.00	0.00	0.00	3.
1.01	14.00	28	[illegible]	[illegible]	[illegible]	287.	1.02	15.00	78	0.00	0.00	0.00	2.
1.01	14.30	29	[illegible]	[illegible]	[illegible]	272.	1.02	15.30	79	0.00	0.00	0.00	2.
1.01	15.00	30	[illegible]	[illegible]	[illegible]	242.	1.02	16.00	80	0.00	0.00	0.00	2.
1.01	15.30	31	[illegible]	.05	[illegible]	214.	1.02	16.30	81	0.00	0.00	0.00	2.
1.01	16.00	32	[illegible]	.05	[illegible]	175.	1.02	17.00	82	0.00	0.00	0.00	2.
1.01	16.30	33	[illegible]	.05	[illegible]	145.	1.02	17.30	83	0.00	0.00	0.00	2.
1.01	17.00	34	[illegible]	.05	.04	123.	1.02	18.00	84	0.00	0.00	0.00	1.
1.01	17.30	35	.08	[illegible]	.04	106.	1.02	18.30	85	0.00	0.00	0.00	1.
1.01	18.00	36	[illegible]	[illegible]	.04	93.	1.02	19.00	86	0.00	0.00	0.00	1.
1.01	18.30	37	[illegible]	[illegible]	[illegible]	84.	1.02	19.30	87	0.00	0.00	0.00	1.
1.01	19.00	38	[illegible]	.02	[illegible]	76.	1.02	20.00	88	0.00	0.00	0.00	1.
1.01	19.30	39	.04	.02	.02	68.	1.02	20.30	89	0.00	0.00	0.00	1.
1.01	20.00	40	.04	.02	.02	60.	1.02	21.00	90	0.00	0.00	0.00	1.
1.01	20.30	41	.04	.02	.02	53.	1.02	21.30	91	0.00	0.00	0.00	1.
1.01	21.00	42	.04	.03	.02	47.	1.02	22.00	92	0.00	0.00	0.00	1.
1.01	21.30	43	.04	.03	.02	45.	1.02	22.30	93	0.00	0.00	0.00	1.

1.01	22.00	44	.04	.03	.02	40.		1.02	23.00	94	0.00	0.00	0.00	1.
1.01	22.30	45	.04	.03	.02	38.		1.02	23.30	95	0.00	0.00	0.00	1.
1.01	23.	46	.04	.03	.02	37.		1.03	0.00	96	0.00	0.00	0.00	0.
1.01	23.30	47	.04	.03	.02	37.		1.03	.30	97	0.00	0.00	0.00	0.
1.02	0.00	48	.04	.03	.02	36.		1.03	1.00	98	0.00	0.00	0.00	0.
1.02	.30	49	0.00	0.00	0.00	35.		1.03	1.30	99	0.00	0.00	0.00	0.
1.02	1.00	50	0.00	0.00	0.00	32.		1.03	2.00	100	0.00	0.00	0.00	0.
										SUM	7.21	2.13	5.09	3291.
											(183.)(	54.)(	129.)(	93.19)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	292.	178.	65.	33.	3287.
CMS	8.	5.	2.	1.	93.
INCHES		1.54	2.23	2.36	2.36
MM		39.07	56.73	60.03	60.03
AC-FT		88.	128.	136.	136.
THOUS CU M		109.	158.	168.	168.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

100-YR FLOOD ROUTING THROUGH UPPER POND (CULVERT)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
U POND	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-845.	-1

STAGE	844.90	845.00	845.50	846.00	846.50	847.00	847.50	848.00	848.50	849.00
FLOW	0.00	11.00	26.00	36.00	43.00	126.00	491.00	1238.00	2495.00	4376.00

SURFACE AREA=	0.	7.	9.	13.	14.	15.	16.	17.	20.	23.
CAPACITY=	0.	2.	10.	32.	45.	60.	68.	76.	95.	116.
ELEVATION=	840.	841.	842.	844.	845.	846.	846.5	847.	848.	849.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
846.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
846.5	0.0	0.0	0.

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**********          **********          **********          **********          **********

                              SUBAREA RUNOFF COMPUTATION

           100-YR INFLOW TO L [illegible] POND BASIN [illegible] SULLIVAN PRECIP, 30 MIN. INTERVALS

                     ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                    RUNOFF       0       0       0       0       0       1       0       0

                                         HYDROGRAPH DATA
           IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
               0      2     .66    0.00     .66    0.00   0.000       0       0       0

                                          PRECIP DATA
                              NP    STORM     DAJ     DAK
                             -48     0.00    0.00    0.00

                                           LOSS DATA
        LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
            0    0.00    0.00    1.00    0.00    0.00    1.00   -1.00  -56.00    0.00     .13

             CURVE NO =  -56.00   WETNESS =   -1.00   EFFECT CN =   56.00

                                      UNIT HYDROGRAPH DATA
                                   TC=  0.00      LAG=  2.01

                                         RECESSION DATA
                           STRTQ=  -10.00    QRCSN=    -.10    RTIOR= 2.50

         UNIT HYDROGRAPH 22 END OF PERIOD ORDINATES, TC=    0.00 HOURS, LAG=   2.01  VOL= 1.00
        17.       53.      107.      137.      158.      117.       87.       58.       40.       28.
        20.       14.       10.        7.        5.        3.        2.        2.        1.        1.
         0.        0.

     0
                                              END-OF-PERIOD FLOW
  MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q      MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS   COMP Q

   1.01    .30       1    .04    .01    .04        6.       1.02   1.30      51   0.00   0.00   0.00      21.
   1.01   1.00       2    .04    .01    .04        6.       1.02   2.00      52   0.00   0.00   0.00      19.
   1.01   1.30       3    .04    .01    .04        6.       1.02   2.30      53   0.00   0.00   0.00      18.
   1.01   2.00       4    .04    .01    .04        6.       1.02   3.00      54   0.00   0.00   0.00      16.
   1.01   2.30       5    .04    .01    .04        7.       1.02   3.30      55   0.00   0.00   0.00      15.
   1.01   3.00       6    .04    .01    .04        7.       1.02   4.00      56   0.00   0.00   0.00      13.
   1.01   3.30       7    .04    .01    .04        7.       1.02   4.30      57   0.00   0.00   0.00      12.
   1.01   4.00       8    .04    .01    .04        7.       1.02   5.00      58   0.00   0.00   0.00      11.
```

1.01	4.30	9	.04	.01	.04	7.	1.02	5.30	59	0.00	0.00	0.00	10.
1.01	5.00	10	.04	.01	.04	7.	1.02	6.00	60	0.00	0.00	0.00	9.
1.01	5.30	11	.04	.01	.04	7.	1.02	6.30	61	0.00	0.00	0.00	8.
1.01	6.00	12	.04	.01	.04	7.	1.02	7.00	62	0.00	0.00	0.00	8.
1.01	6.30	13	.08	.01	.07	7.	1.02	7.30	63	0.00	0.00	0.00	7.
1.01	7.00	14	.08	.01	.07	7.	1.02	8.00	64	0.00	0.00	0.00	6.
1.01	7.30	15	.08	.01	.07	7.	1.02	8.30	65	0.00	0.00	0.00	6.
1.01	8.00	16	.08	.01	.07	8.	1.02	9.00	66	0.00	0.00	0.00	5.
1.01	8.30	17	.08	.01	.07	8.	1.02	9.30	67	0.00	0.00	0.00	5.
1.01	9.00	18	.08	.01	.07	9.	1.02	10.00	68	0.00	0.00	0.00	4.
1.01	9.30	19	.13	.02	.11	10.	1.02	10.30	69	0.00	0.00	0.00	4.
1.01	10.00	20	.13	.02	.11	10.	1.02	11.00	70	0.00	0.00	0.00	4.
1.01	10.30	21	.13	.02	.11	11.	1.02	11.30	71	0.00	0.00	0.00	3.
1.01	11.00	22	.19	.02	.17	12.	1.02	12.00	72	0.00	0.00	0.00	3.
1.01	11.30	23	.37	.06	.31	14.	1.02	12.30	73	0.00	0.00	0.00	3.
1.01	12.00	24	1.45	.48	.97	24.	1.02	13.00	74	0.00	0.00	0.00	3.
1.01	12.30	25	1.35	.46	.89	60.	1.02	13.30	75	0.00	0.00	0.00	2.
1.01	13.00	26	.37	.22	.14	124.	1.02	14.00	76	0.00	0.00	0.00	2.
1.01	13.30	27	.19	.12	.07	198.	1.02	14.30	77	0.00	0.00	0.00	2.
1.01	14.00	28	.13	.08	.05	242.	1.02	15.00	78	0.00	0.00	0.00	2.
1.01	14.30	29	.13	.09	.05	247.	1.02	15.30	79	0.00	0.00	0.00	2.
1.01	15.00	30	.13	.09	.05	225.	1.02	16.00	80	0.00	0.00	0.00	1.
1.01	15.30	31	.08	.06	.03	184.	1.02	16.30	81	0.00	0.00	0.00	1.
1.01	16.00	32	.08	.06	.03	147.	1.02	17.00	82	0.00	0.00	0.00	1.
1.01	16.30	33	.08	.06	.03	121.	1.02	17.30	83	0.00	0.00	0.00	1.
1.01	17.00	34	.08	.06	.03	101.	1.02	18.00	84	0.00	0.00	0.00	1.
1.01	17.30	35	.08	.06	.03	85.	1.02	18.30	85	0.00	0.00	0.00	1.
1.01	18.00	36	.08	.06	.03	74.	1.02	19.00	86	0.00	0.00	0.00	1.
1.01	18.30	37	.04	.03	.01	66.	1.02	19.30	87	0.00	0.00	0.00	1.
1.01	19.00	38	.04	.03	.01	59.	1.02	20.00	88	0.00	0.00	0.00	1.
1.01	19.30	39	.04	.03	.01	52.	1.02	20.30	89	0.00	0.00	0.00	1.
1.01	20.00	40	.04	.03	.01	46.	1.02	21.00	90	0.00	0.00	0.00	1.
1.01	20.30	41	.04	.03	.01	40.	1.02	21.30	91	0.00	0.00	0.00	1.
1.01	21.00	42	.04	.03	.01	35.	1.02	22.00	92	0.00	0.00	0.00	0.
1.01	21.30	43	.04	.03	.01	32.	1.02	22.30	93	0.00	0.00	0.00	0.
1.01	22.00	44	.04	.03	.01	30.	1.02	23.00	94	0.00	0.00	0.00	0.
1.01	22.30	45	.04	.03	.01	28.	1.02	23.30	95	0.00	0.00	0.00	0.
1.01	23.00	46	.04	.03	.01	27.	1.03	0.00	96	0.00	0.00	0.00	0.
1.01	23.30	47	.04	.03	.01	26.	1.03	.30	97	0.00	0.00	0.00	0.
1.02	0.00	48	.04	.03	.01	26.	1.03	1.00	98	0.00	0.00	0.00	0.
1.02	.30	49	0.00	0.00	0.00	25.	1.03	1.30	99	0.00	0.00	0.00	0.
1.02	1.00	50	0.00	0.00	0.00	23.	1.03	2.00	100	0.00	0.00	0.00	0.
									SUM	7.21	2.99	4.22	2763.
										(183.)(	76.)(	107.)(	78.24)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	247.	151.	54.	28.	2765.
CMS	7.	4.	2.	1.	78.
INCHES		2.14	3.07	3.27	3.27
MM		54.34	77.95	82.99	82.99
AC-FT		75.	107.	114.	114.
THOUS CU M		92.	132.	141.	141.

```
**********          **********          **********          **********          **********

                                    COMBINE HYDROGRAPHS

                   COMBINATION OF OUTFLOW FROM UPPER LAKE AND RUNOFF OF LOWER WATERSHED

                          ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                          UP+LOW      2       0       0       0       0       1       0       0


**********          **********          **********          **********          **********

                                    HYDROGRAPH ROUTING

                100-YR FLOOD ROUTING THROUGH LOWER POND

                          ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                          L POND      1       0       0       0       0       1       0       0
                                                ROUTING DATA
                  QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                    0.0   0.000    0.00       1       1       0       0               0

                          NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                              1       0       0   0.000   0.000   0.000   -842.      -1

STAGE          842.30     843.00     843.50     844.00     844.50     845.00     845.50     846.00     847.10     848.00

FLOW             0.00      66.00     182.00     345.00     551.00     809.00    1110.00    1520.00    2700.00    3873.00

SURFACE AREA=       0.         7.        17.        33.        49.        54.        62.        64.

CAPACITY=           0.         5.        16.        41.        82.       133.       249.       280.

ELEVATION=        838.       840.       841.       842.       843.       844.       846.       847.

                       CREL    SPWID    COQW    EXPW   ELEVL    COQL   CAREA    EXPL
                      842.3      0.0     0.0     0.0     0.0     0.0     0.0     0.0

                                               DAM DATA
                                        TOPEL    COQD    EXPD  DAMWID
                                        847.1     0.0     0.0      0.
```

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN	RATIO 1 1.00
HYDROGRAPH AT	INFLOW	1.08 (2.79)	1	292. (8.28)(
ROUTED TO	U POND	1.08 (2.79)	1	237. (6.70)(
HYDROGRAPH AT	RUNOFF	.66 (1.70)	1	247. (7.00)(
2 COMBINED	UP+LOW	1.73 (4.49)	1	451. (12.76)(
ROUTED TO	L POND	1.73 (4.49)	1	259. (7.34)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 100 - Year

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	845.00	846.50	846.50
STORAGE	45.	68.	68.
OUTFLOW	11.	43.	43.

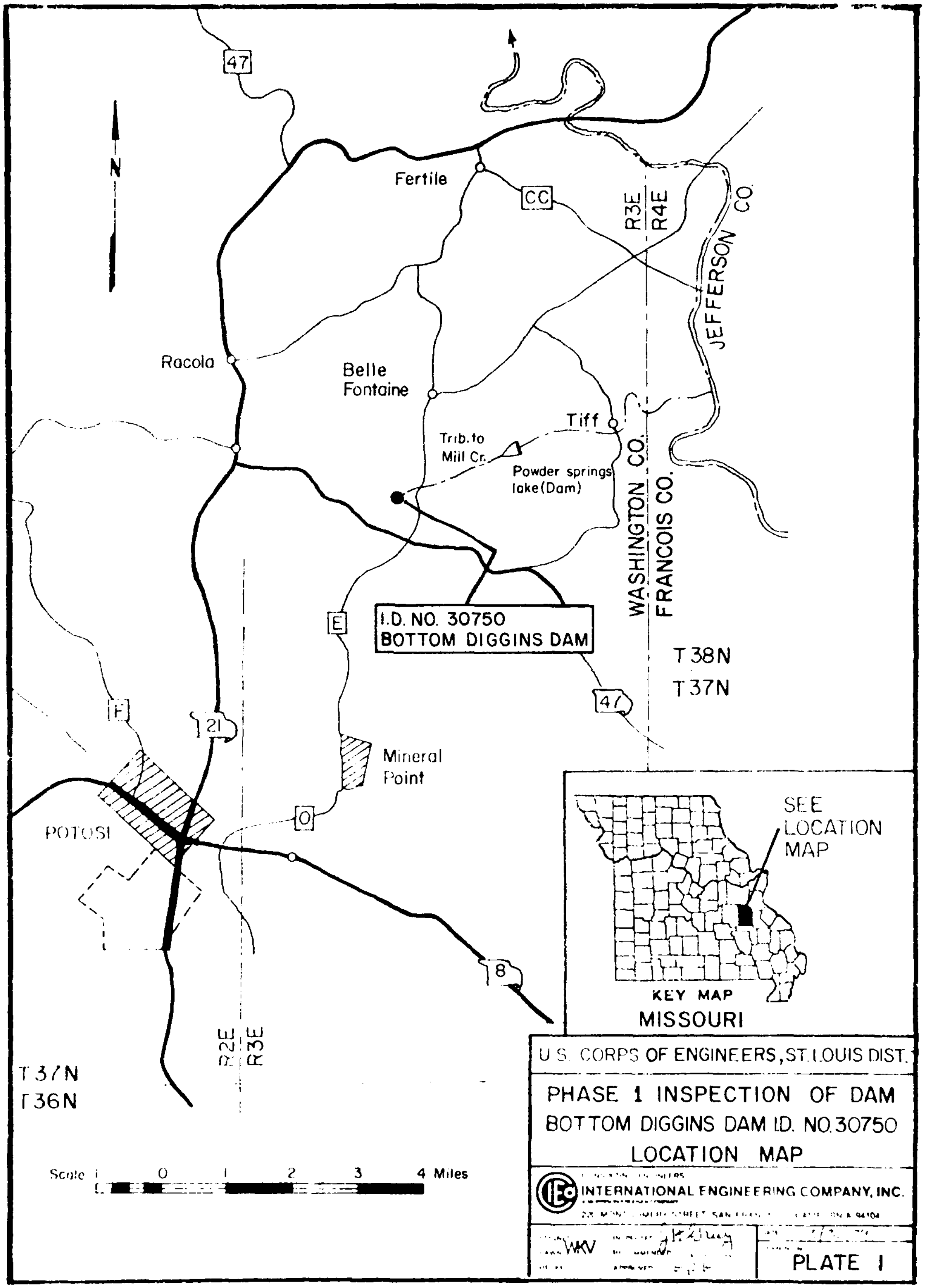
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	847.15	.65	79.	237.	9.00	15.50	0.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 100 - Year

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	842.30	842.30	847.10
STORAGE	51.	51.	320.
OUTFLOW	0.	0.	2700.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	843.74	0.00	119.	259.	0.00	17.00	0.00



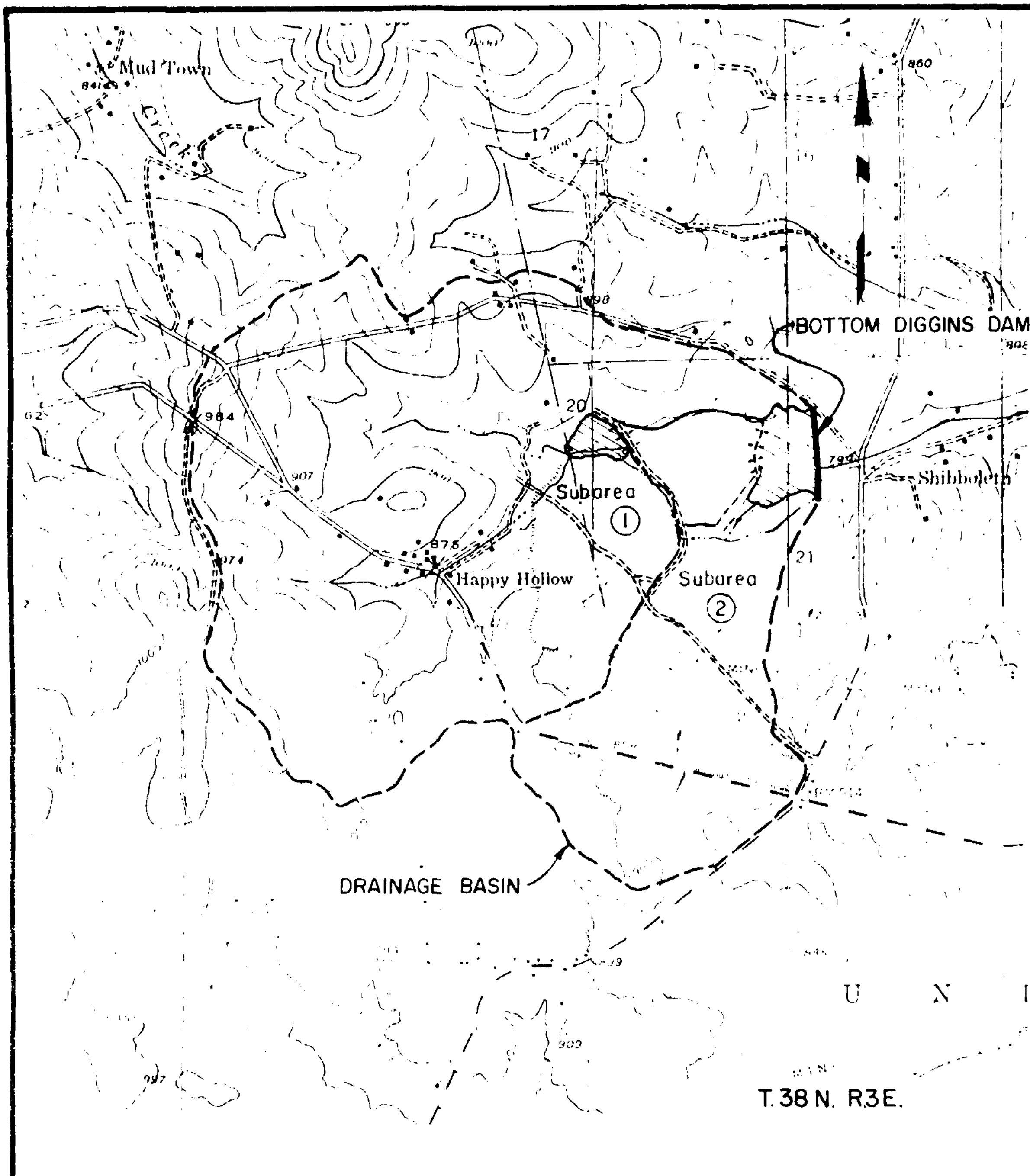
U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.

PHASE 1 INSPECTION OF DAM
BOTTOM DIGGINS DAM I.D. NO. 30750
LOCATION MAP

INTERNATIONAL ENGINEERING COMPANY, INC.

WKV

PLATE 1



Scale 1000 0 1000 2000 3000 4000 Feet

U S CORPS OF ENGINEERS, ST. LOUIS DIST.

PHASE I INSPECTION OF DAMS
BOTTOM DIGGINS DAM I.D. NO. 30750
VICINITY TOPOGRAPHY

INTERNATIONAL ENGINEERING COMPANY, INC.

PLATE 2

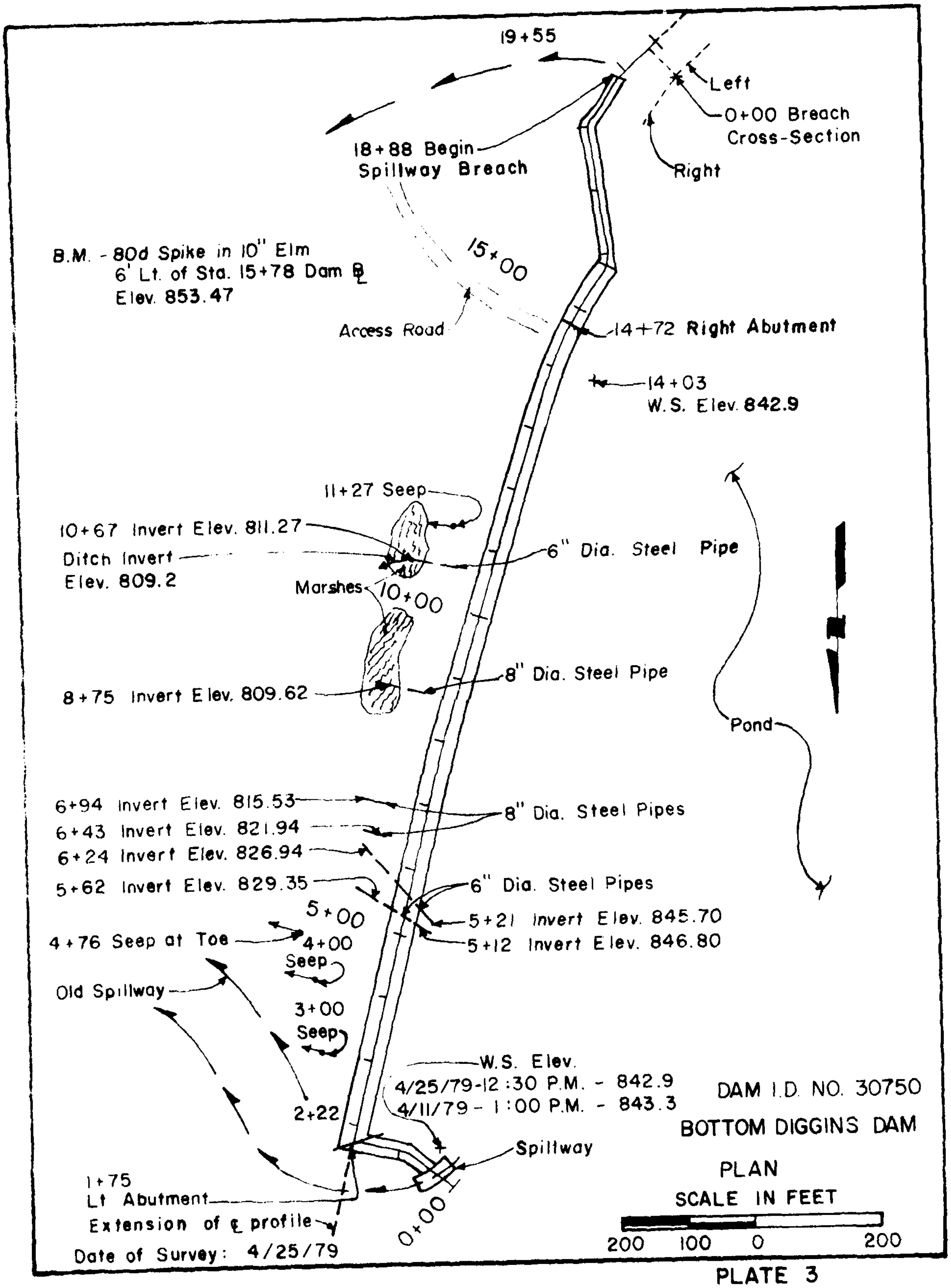
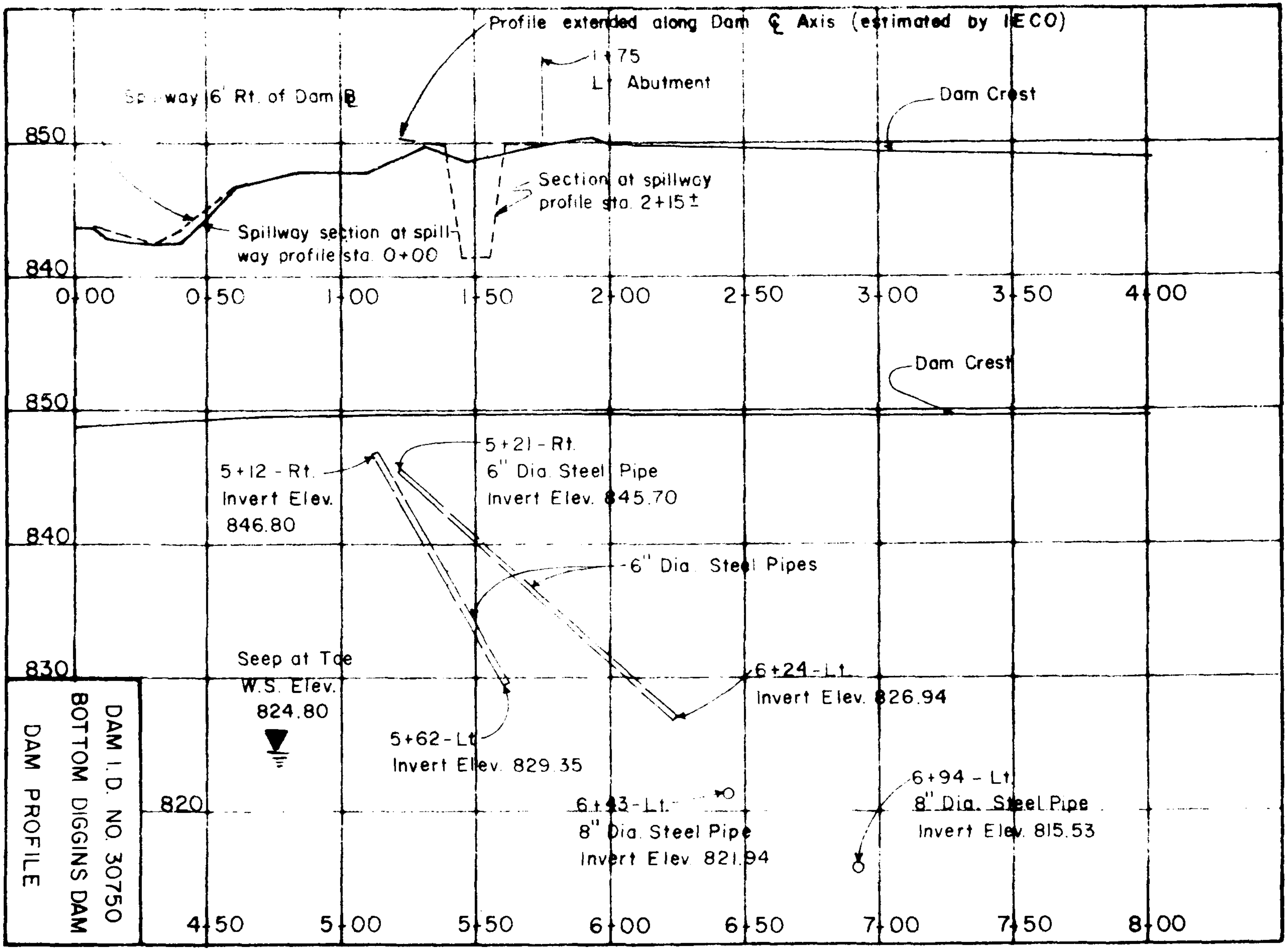

19+55
Left
0+00 Breach
Cross-Section
Right
18+88 Begin
Spillway Breach
B.M. - 80d Spike in 10" Elm
6' Lt. of Sta. 15+78 Dam ℄
Elev. 853.47
15+00
Access Road
14+72 Right Abutment
14+03
W.S. Elev. 842.9
11+27 Seep
10+67 Invert Elev. 811.27
Ditch Invert
Elev. 809.2
6" Dia. Steel Pipe
Marshes
10+00
8" Dia. Steel Pipe
8+75 Invert Elev. 809.62
Pond
6+94 Invert Elev. 815.53
8" Dia. Steel Pipes
6+43 Invert Elev. 821.94
6+24 Invert Elev. 826.94
5+62 Invert Elev. 829.35
6" Dia. Steel Pipes
5+00
5+21 Invert Elev. 845.70
5+12 Invert Elev. 846.80
4+76 Seep at Toe
4+00
Seep
Old Spillway
3+00
Seep
W.S. Elev.
4/25/79-12:30 P.M. - 842.9
4/11/79 - 1:00 P.M. - 843.3
2+22
Spillway
1+75
Lt Abutment
Extension of ℄ profile
0+00
Date of Survey: 4/25/79
DAM I.D. NO. 30750
BOTTOM DIGGINS DAM
PLAN
SCALE IN FEET
200 100 0 200

PLATE 3



DAM I.D. NO. 30750
BOTTOM DIGGINS DAM
DAM PROFILE

PLATE 4A

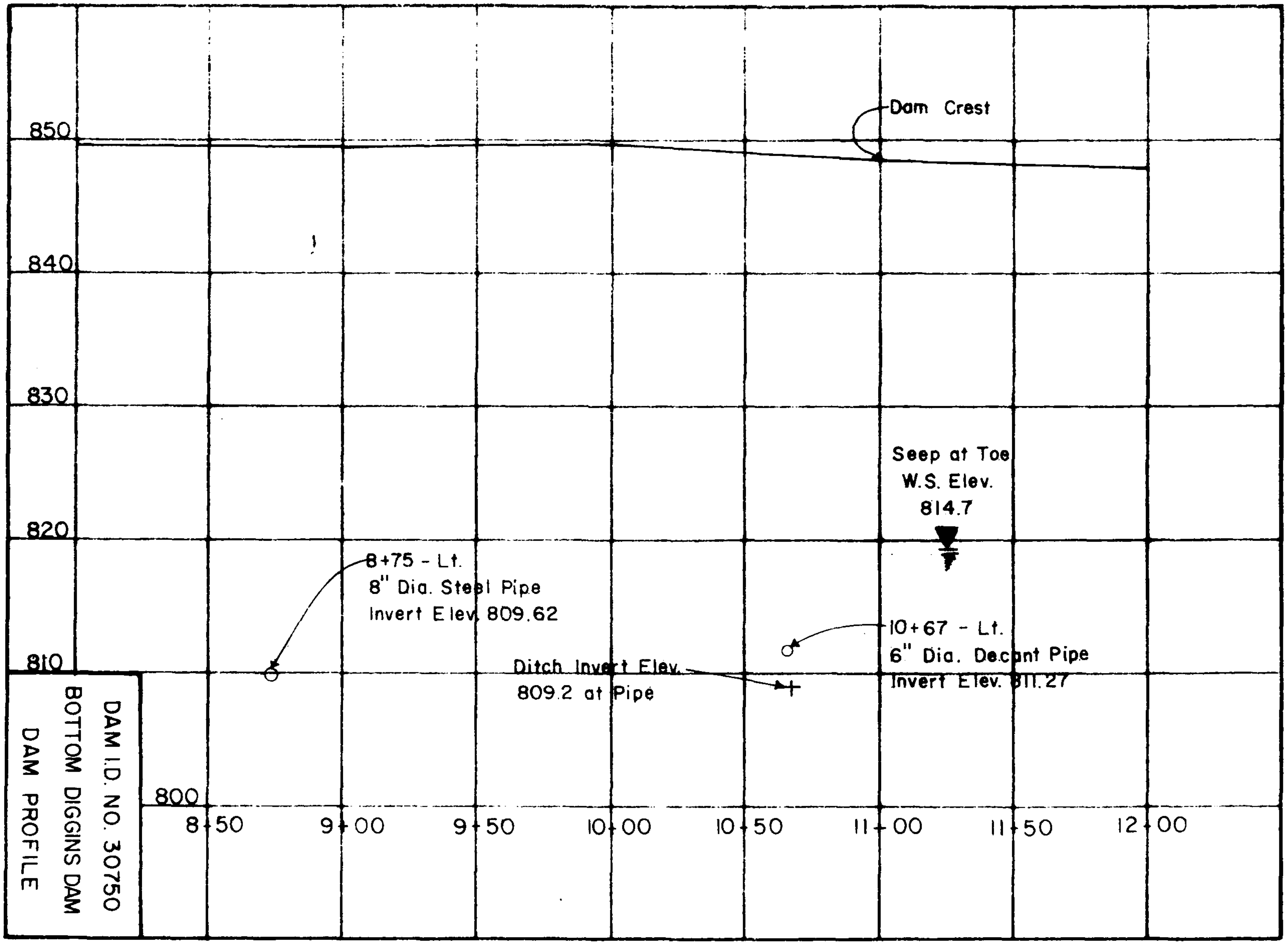
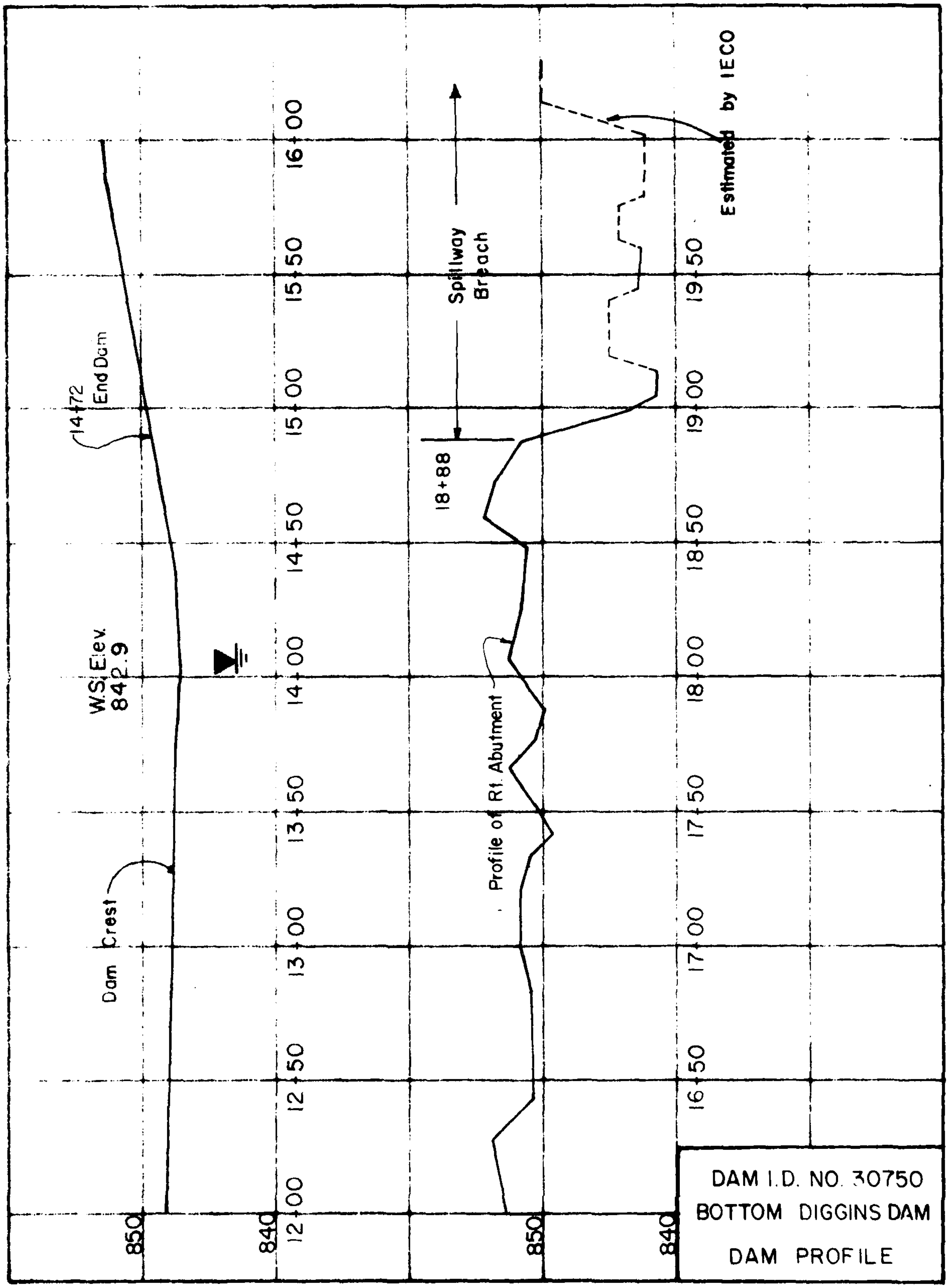
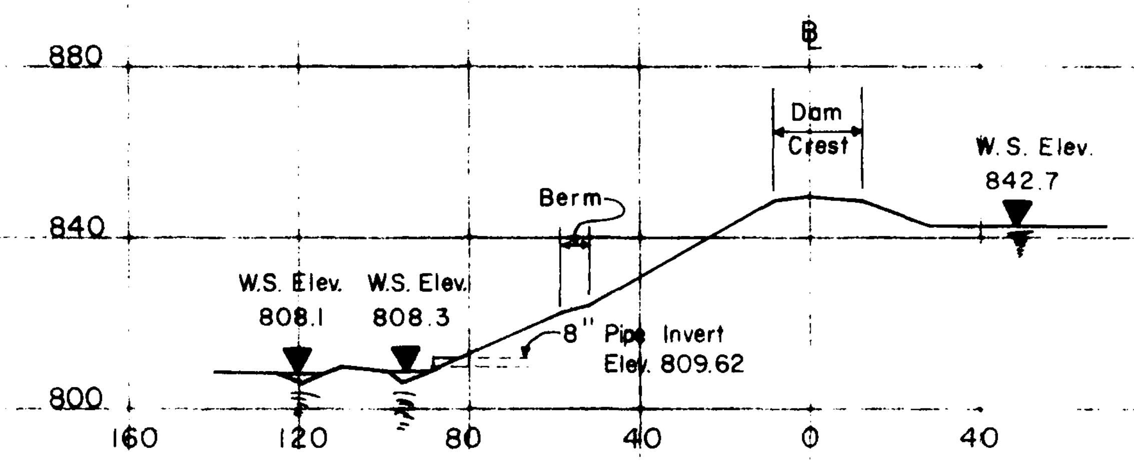

Dam Crest
Seep at Toe
W.S. Elev.
814.7
8+75 - Lt.
8" Dia. Steel Pipe
Invert Elev. 809.62
Ditch Invert Elev.
809.2 at Pipe
10+67 - Lt.
6" Dia. Decant Pipe
Invert Elev. 811.27
850
840
830
820
810
800
8+50
9+00
9+50
10+00
10+50
11+00
11+50
12+00
DAM I.D. NO. 30750
BOTTOM DIGGINS DAM
DAM PROFILE

PLATE 4B

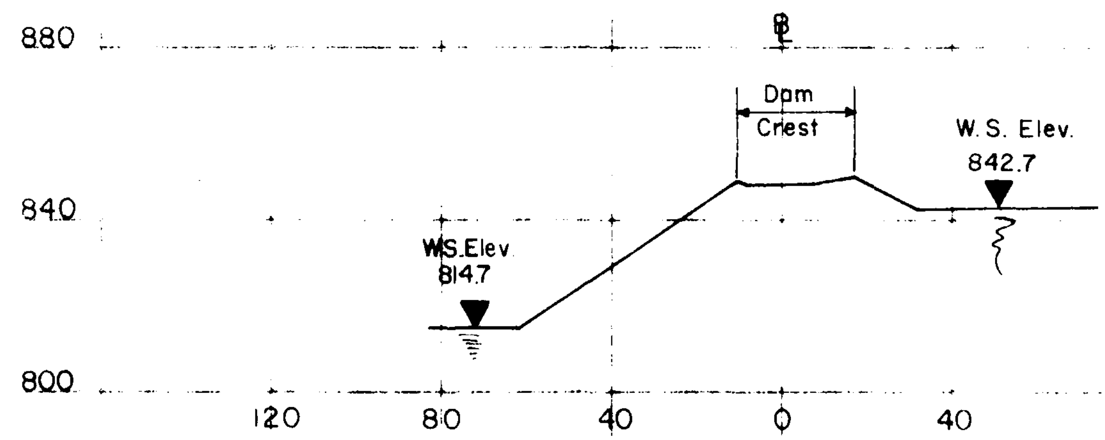


DAM I.D. NO. 30750
BOTTOM DIGGINS DAM
DAM PROFILE

PLATE 4C



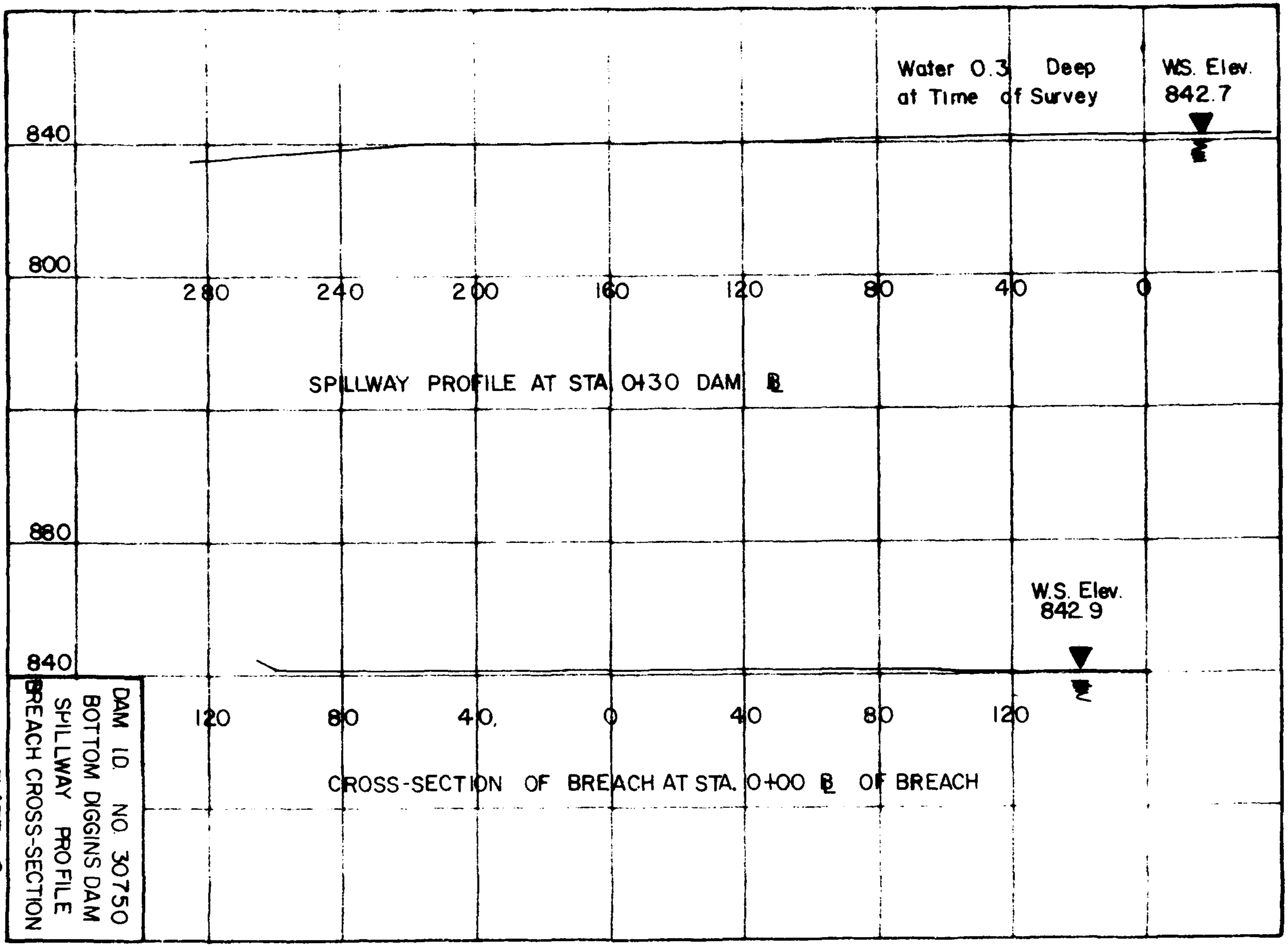
DAM CROSS-SECTION AT STATION 8+75 DAM ℄



DAM CROSS-SECTION AT STATION 11+18 DAM ℄

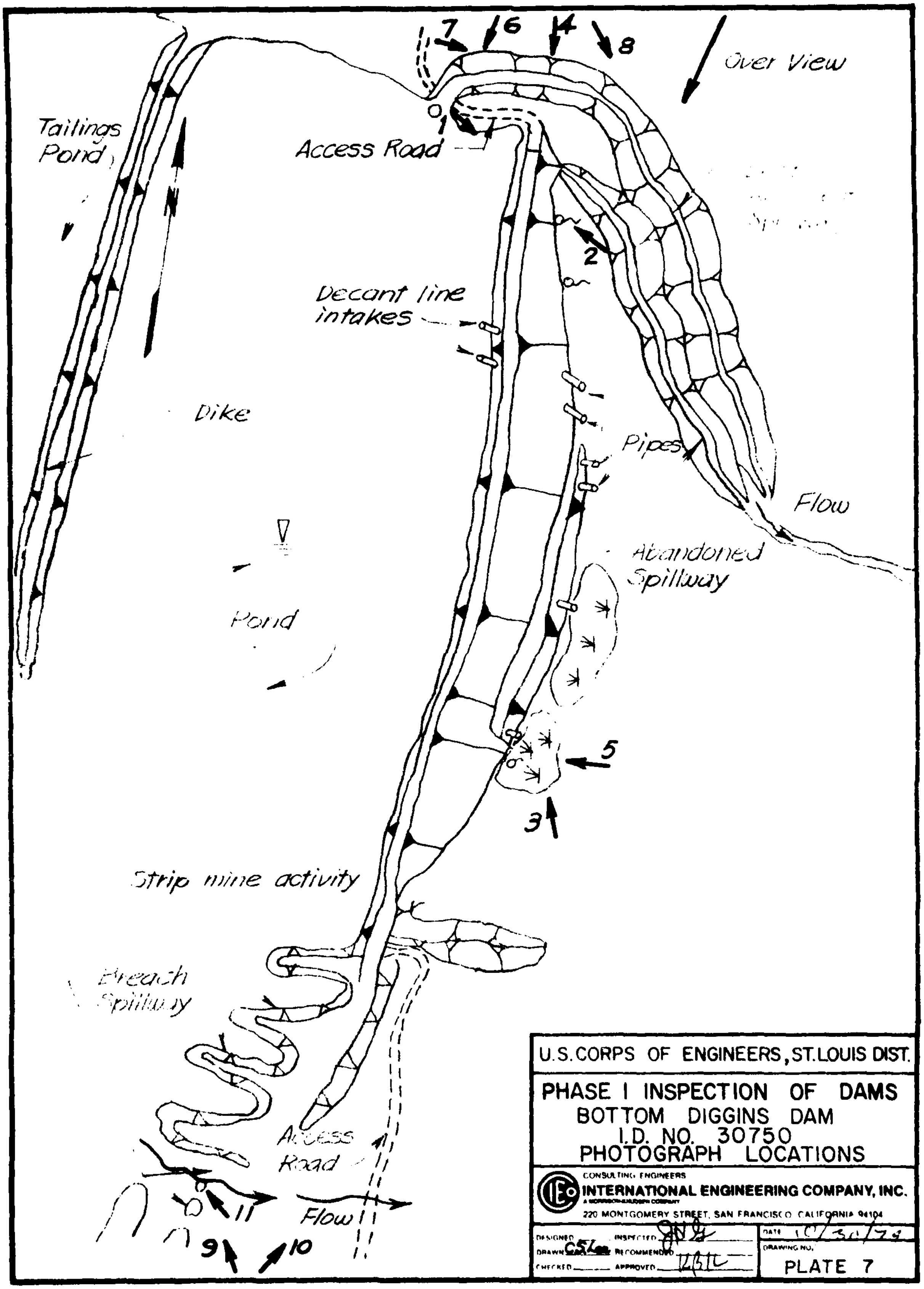
DAM I.D. NO. 30750
BOTTOM DIGGINS DAM
DAM CROSS-SECTIONS

PLATE 5



DAM I.D. NO. 30750
BOTTOM DIGGINS DAM
SPILLWAY PROFILE
BREACH CROSS-SECTION

PLATE 6



U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.

PHASE I INSPECTION OF DAMS
BOTTOM DIGGINS DAM
I.D. NO. 30750
PHOTOGRAPH LOCATIONS

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY
220 MONTGOMERY STREET, SAN FRANCISCO, CALIFORNIA 94104

DESIGNED	INSPECTED	DATE 10/30/79
DRAWN CSL	RECOMMENDED	DRAWING NO.
CHECKED	APPROVED	PLATE 7

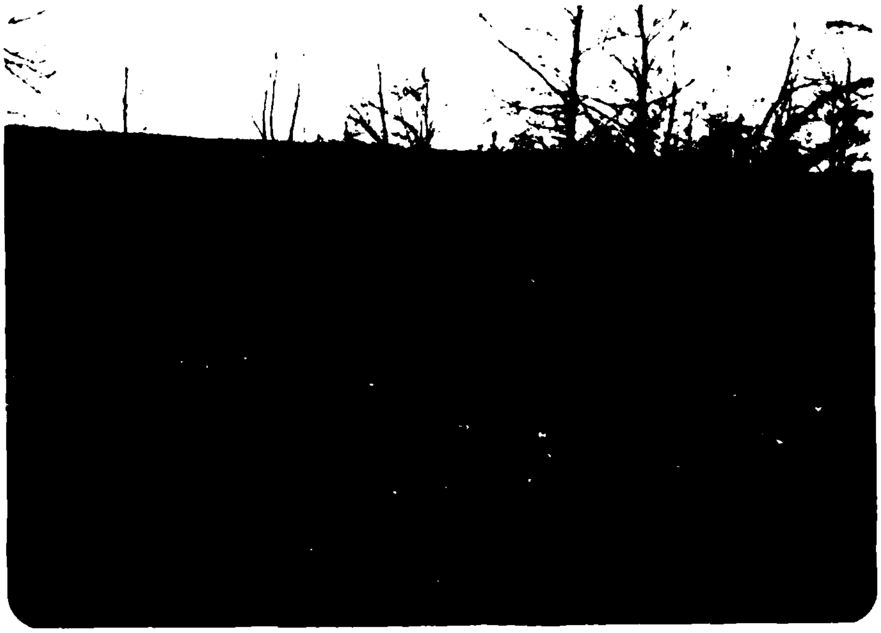
PHOTOGRAPH RECORD

BOTTOM DIGGINS DAM - I.D. NO. 30750

Photo No.	Description
1.	Dam crest near Station 2+00. Note eroded breach on up-stream slope.
2.	Seep at Station 3+00.
3.	View of dam toe and buried pipe at Station 10+67. Note marsh at dam toe.
4.	View south of dam crest from left abutment spillway.
5.	Seep at dam toe at Station 11+27.
6.	Spillway inlet on left abutment.
7.	Spillway channel looking downstream at left abutment of dam on right.
8.	Spillway channel downstream of dam axis. Note erosion of channel slopes.
9.	View of breached area in reservoir.
10.	View of breached area and right abutment of dam.
11.	View of breach channel.

1

2



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